MORANG'S MODERN NATURE STUDY

SILCOX & STEVENSON

A. M. Philips

A. M. de Wolff

MODERN NATURE STUDY

Barn Swallow.

Kingfisher.

A STUDY IN ADAPTATION.

MORANG'S TWENTIETH CENTURY TEXT-BOOKS

MODERN NATURE STUDY

A FIRST BOOK

FOR USE IN CANADIAN SCHOOLS

PART I. MATTER. PART II. METHOD.

WITH COLORED PLATES AND NUMEROUS ILLUSTRATIONS, MANY OF WHICH ARE FROM ORIGINAL PHOTOGRAPHS

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PREFACE

IN placing this manual before Canadian teachers the authors do not feel that it is necessary to advance any plea for Nature Study. It finds its justification in the conditions of modern society, and rests upon the same psychological basis as Manual Training and Domestic Science. The necessity for Nature Study has been recognized by the most advanced educators both in Canada and the United States, and it is only a matter of time till it will find a permanent place among the subjects of study.

The value of any subject of study must ultimately be judged from a social standpoint; and Nature Study must prove an important agent, not only in training the faculties of the individual, but also in making him acquainted with the elementary material and the processes upon which our whole social life depends. It is upon this phase of Nature Study as a socializing agent, that we desire in this manual to lay the greatest stress; and the teacher must not lose sight of this side of the subject if he desires to give vitality to his presentation.

It has been impossible for us within the limits of this manual to indicate in detail the various ways in which Nature Study may be of assistance in the teaching of other subjects, composition, geography, etc. On its social side it is related to every subject of the school course, and the points of contact will readily suggest themselves to the teacher.

Part I. of the manual has been devoted to the outline of a field of Nature Study and to the presentation of the main facts regarding the different forms of animal and plant life.

If it were at all possible, it would of course be better that each individual teacher and student should observe and ascertain these facts for himself. The manifest absurdity of such a course, however, becomes apparent when we consider the width of the field to be covered. Years of unaided observation, even to a mind of a scientific turn, could serve to make the student acquainted only with the barest outlines, and the beginner must, in the majority of cases, eventually become discouraged. The aim of the authors of this manual in supplying the information given in Part I. is not to prevent observation on the part of the teacher, but to stimulate observation, and to render it intelligent and fruitful. In no case have we attempted to give more than a mere outline of any animal or plant. The main facts given, it remains for the teacher himself to make a detailed study as indicated in the outline lessons in Part II.

The work is profusely illustrated, the object of the illustrations being to convey information in the most direct and economical way. No illustration or verbal description, however, can adequately represent life, and it is life that the student of nature should study. If this book stimulates interest in living things our object will have been accomplished.

Teachers should read Part II. before attempting to make use of Part I. We commend especially the selection on "The Social Side of Nature Study."

Many teachers are afraid to undertake this work because their knowledge of plant and animal life is so limited. This should rather be an incentive to learn with the pupils. All that is needed is confidence in one's own power to observe and interpret the phenomena of life.

O. J. S.

St. Thomas, Aug., 1902. S. S.

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NATURE STUDY

PART I

Some Mammals of Canada.

THE STUDY OF MAMMALS

I. THE FIELD OF STUDY

The Mammals are the highest forms of animal life. They are distinguished from the lower orders of life by several well-marked characteristics. Most of them are four-footed, covered with hair, and live on land ; and the young are in all cases fed with milk. The brain of the mammals is much more highly developed than that of the lower forms of life, a fact which makes the study of them more difficult, but at the same time more interesting to the nature student.

The Mammals of North America include about eighty species, ranging in size from the whale, seventy feet in length, to the least shrew, which is only two inches long. Between these different mammals noticeable differences in form and structure exist, due principally to their different methods of securing food and of moving from place to place ; and it is these differences which form the basis of classification. For example, the gnawing mammals have strong, chisel-shaped teeth ; the leapers have long, strong hind-legs and bushy tails ; the diggers have powerful fore-feet ; the swimmers have webbed hind-feet and flat tails ; the borers have strong, muscular heads and shoulders ; and the fliers have flexible wing-membranes.

Taking these differences as a basis for classification, North American mammals are divided into eight orders, as follows: –

I. Marsupialia, or Pouched Mammals. (Opossums).
II. Sea Cows.
III. Whales, Dolphins, and Porpoises.
IV Hoofed Quadrupeds. (Deer).
V. Carnivora, or Flesh-eaters. (Raccoons, Skunks, Weasels, Foxes, Badgers, and Coyotes).
VI. Rodents, or Gnawers. (Woodchucks, Porcupines, Rabbits, Muskrats, Squirrels, Mice, Prairie Dogs, and Gophers).
VII. Insectivora, or Insect-eaters. (Moles and Shrews).
VIII. Wing-handed Mammals. (Bats).

In Canada in general the study of Mammals is restricted to certain species belonging to the last five classes, including—the deer, elk, moose, caribou; bear, wolf, fox, lynx, wolverine, otter, raccoon, skunk, weasel, stoat or ermine, mink, fisher, marten; beaver, woodchuck, porcupine, northern hare, wood-hare, muskrat, squirrel, chipmunk, rat, field-mouse; mole, shrew; and bat.

Some of these animals are found only in the rough and unsettled parts of the country; others exist only in limited numbers; while the remainder, in most cases, live in such close concealment that their very existence is unknown to the majority of people. This condition of affairs is due partly to the gradual clearing up of the country; partly to the looseness with which the game laws are enforced, and to the activity of trappers and hunters; and partly to the fact that the farmers consider the majority of the wild animals to be more or less destructive, and do all in their power to destroy them or drive them out.

Under these conditions the work of the nature student must necessarily be difficult. There is, nevertheless, very

much that he may accomplish even under unfavorable circumstances. We have, in reality, very little minute and accurate information regarding the life of the wild animals in this country. It remains for the enthusiastic nature student to make accurate observations, so as to ascertain in detail their habits and characteristics. Books relating to wild animals are of course of assistance to the beginner, and much can be learned from conversation with trappers and hunters, and with observant farmers; but all such information must be verified and supplemented by patient observation on the part of the student himself.

Aside, however, from a personal study of animal life, the nature student can do much for the protection of wild animals. It is quite possible that the animal which the farmer loudly denounces as a thief, often more than atones for his petty depredations, in the destruction of weeds, insects, or rodents which are themselves in the highest degree objectionable. The naturalist can perform a double duty by helping the farmer to a proper appreciation of his true friends and enemies. Besides this, he can in many ways awaken an interest in the wild animals and a sympathy with them in their struggle for existence, and can endeavor to secure the co-operation of others in his efforts on their behalf.

II. RECOGNITION OF THE MAMMALS

Our study of certain of the Mammals is practically limited to what we read of them, or what we hear from trappers and hunters. Some of them, such as the bear, the lynx, the deer, and the beaver, are to be found only in the wilde nesses of the northern districts; others, such as the porcupine, are met with only in the rougher portions of the country; while still others, such as the fox, the mink, the weasel, the water-rat, and the shrew, exist only in such limited numbers and live in such close concealment that observation is all but impossible.

Interesting accounts of these animals will be found in Long's *Wilderness Ways*, and *Ways of Wood-folk*, Burrough's *Squirrels and other Fur-bearers*, Seton-Thompson's *Lobo*, *Rag and Vixen*, or *Wild Animals I Have Known*, and Mabel Osgoode Wright's *Four-footed Americans*. The style of these books is admirable and they will be found to contain excellent material for reading to classes.

The remaining Mammals, the raccoon, the skunk, the woodchuck, the rabbit, the muskrat, the squirrel, the field-mouse, the mole, and the bat, are generally distributed, and are found in sufficient numbers to render it possible for the nature student to make a detailed study of any of them. In the following paragraphs only such information is given regarding them as will assist identification and facilitate observation.

I. CARNIVORA, OR FLESH-EATERS.

1. The Raccoon. Body, 27 inches; tail, 11 inches. Found in thick woods, generally near a stream or a marsh.

The Raccoon, or 'Coon,' is generally spoken of as a diminutive bear, on account of its appearance and habits. It

is grayish-black in color, and furthermore may be readily recognized by its sharp nose, black face-markings, plantigrade (or flat-soled) feet, arched hind-quarters, and long tail tipped with black and marked with five black rings.

The native element of the coon is the tree-tops, where he makes his den in the hollow trunk. He does not, however, like the squirrel or the porcupine, gather the nuts or eat the leaves, but descends to the ground in search of food. He will eat frogs, fish, mice, crayfish, birds, chickens and eggs, and is fond of fruit and sweetmeats of all kinds. He is an expert fisher, and is very fond of the water, although he does not dive for fish and crabs, but catches them on shore with his paws. He is very partial to the farmer's corn, and makes frequent visits to the cornfield in early autumn. From his partiality to water, and his peculiar habit of washing his food when possible, before eating it, he has been called "the washing bear," and is technically known as *Lotor*, the *Washer*.

The coon is almost entirely nocturnal in his habits, and is rarely seen by day. The nights of summer and early autumn are spent in feasting. Late in the fall, when he has become fat, he retires with his mate to his den, and sleeps throughout the winter, until February or March. Early in the spring the young are born, five or six in a litter. They remain with the parents sometimes a year, and during the summer and autumn accompany them in family parties in their nocturnal depredations. The cry of the coon, if cry it has, resembles that of the screech-owl very closely. It is, however, claimed by some that the coon has no cry, and that the so-called coon-whistles are in all cases attributable to the screech owl.

2. THE SKUNK. Body, 18 inches; tail, 13 inches. Found in woods or stumpy fields.

The Skunk resembles the raccoon in form, but is smaller in size. Like the coon, it has a pointed nose, plantigrade

Raccoon and Skunk.

feet, arched hindquarters, and long tail. But the arrangement of its markings is in direct contrast to the plan followed by nature in the case of other Mammals. Examine, for example, the picture of the wood-hare (p. 12). The under parts, which are naturally in shadow, are light colored to deceive the eye, while the upper parts are rendered inconspicuous by their resemblance to their surroundings. Compare and contrast with this the markings of the skunk on the opposite page, and notice especially the conspicuous white tail-tip. Can you suggest any reason why the skunk does not require to be protected by markings similar to those of the hare, but should seek, rather than avoid, recognition? Would this reason not also account for the fact that the skunk is in no hurry to move out of the way of those whom he meets in the woods, but seems rather to regard his white tail plume as a danger signal, a warning to all enemies to keep at a safe and proper distance?

The yellow, phosphorescent liquid to which is due the offensive odor of the skunk, common to most of the members of the weasel tribe, is contained in two capsules beneath the tail. It may be discharged either in the form of a fine spray, or in a thin spurt or a double jet, sometimes projected a distance of a dozen feet. It is strongly acid in its property and has been known to destroy the eyesight in some cases. Notwithstanding the possession of such a ready weapon, however, the skunk is a peaceable animal and will not make use of his disagreeable projectile except in case of attack, and then only as a last resort.

The skunk subsists entirely upon animal food and destroys immense numbers of grasshoppers, beetles, toads, frogs, mice, reptiles, eggs of all kinds, chickens, and sometimes even rabbits. He is a good swimmer, and possesses strong claws for digging. He makes his den in a burrow, bedded

with grass, generally under a stump or hollow tree. The young, six to ten in a litter, are born in July, and remain with the parents until the following season. Late in the fall the skunk family go into hibernation, but reappear again in February. Their tracks on the snow are easily distinguished from all others from the fact that they are diagonally placed.

Skunk Tracks.

The skunk is said to be the most silent of all animals, producing no sound whatever, except when striking or stamping on the ground as a sign of impatience.

3 THE WEASEL. Body, 11 inches; tail, 7 inches.
THE MINK. Body, 18 inches; tail, 9 inches.

The Weasel is the most blood-thirsty of the smaller Mammals, and often kills apparently for the mere sake of killing. He makes frequent visits to the farmyard, but seldom carries off the chickens which he kills. The habits of the Mink are similar to those of the Weasel. He is, however, partial to the banks of streams, and is fond of fish. Neither the common red Weasel nor the Mink changes color in winter; the northern variety of Weasel, the Stoat or Ermine, changes to white, however, the tip of the tail alone remaining black.

II RODENTIA, OR GNAWERS

1. THE WOODCHUCK. Body, 14½ inches; tail, 7 inches. Found generally in the fields, or in partially cleared woods.

The Woodchuck, or Ground-hog, is not quite so large as the raccoon, and in most respects is his direct opposite. In color he has no decided markings. His coat is generally reddish-brown, tinged with black on the top of the head, on the tail and on the feet. His color, however, varies with his surroundings, ranging from yellowish-grey to brownish-black.

Woodchucks.

The most noticeable features in his appearance are the large eyes, prominent teeth, flabby and clumsy body, and awkward gait.

As his second name indicates, he is entirely a ground animal, and is, in fact, a big ground squirrel, the next of kin to the chipmunk. His burrow generally has two, and sometimes three, entrances, some ten or twelve feet apart. Compare it in this respect with the burrow of a skunk, and suggest, if possible, a reason for the difference. Off the main passage of the burrow generally run at least two other branches, the one for refuse, the other leading to the living room, which is bedded with grass.

The woodchuck lives entirely on vegetable food, fresh clover being the staple of his fare. Sometimes, however, the farmer's garden comes under tribute, in which case the vegetables, and more especially the peas, suffer severely. He is chiefly nocturnal in his habits, and, being slow of foot, will not venture far from the mouth of his stronghold, the burrow, during the day. His curiosity is strong, and his hearing acute, and he will often come to the mouth of his den to satisfy himself of the nature of any unusual object. You will find it very interesting to watch his movements on such occasions.

The young, three or four in a litter, are born early in May, and before the end of the season are able to shift for themselves. After feeding luxuriously in August and September on the young second-growth clover, the woodchuck, like the coon, retires with his mate to his den, and sleeps throughout the winter. The dates of his hibernation correspond approximately with the dates of the September and March equinoxes. The whistle of the woodchuck is a loud quavering diminuendo, unmistakeable to anyone who has once heard it.

2. THE PORCUPINE.—Body, $2\frac{1}{2}$ feet; tail, $8\frac{1}{2}$ inches

The Porcupine is not generally distributed, but in the rougher districts where it is found, it is an interesting object of study. It lives almost entirely in the tree-tops, making its den in a hole in the trunk, and eating the leaves and bark for food. It is slow of foot, clumsy in its movements, and does not possess as much intelligence as a coon or a woodchuck.

As a means of defence its body and tail are covered with loose quills, so that any enemy that is bold enough to attack it is sure to come off with mouth and paws full of quills which stick into the flesh like so many fish-hooks. The old belief that the porcupine was able to shoot the quills, is, of course, entirely erroneous.

The Porcupine.

The Wood Hare or Cottontail Rabbit.

3. THE WOOD HARE. Body, 16 inches; tail, $2\frac{1}{4}$ inches. Found in woods with thick undergrowth, in hay and grain fields, and in the vicinity of brush piles.

The Gray, or Cottontail Rabbit is more properly known as the **Wood Hare,** for, properly speaking, there are no rabbits in Canada. The distinctions between the rabbit and the hare are simple and may be briefly stated as follows :

(1) Hares do not live in burrows as rabbits do, but occupy "forms" or nests, in hollow stumps or logs, or under brush-heaps, or in the long grass of the hay field.

(2) Hares are born with their eyes open, three to five in a litter, in May and July, and are covered with hair at the time of birth. Rabbits are born naked, and with their eyes closed, five to eight in a litter.

(3) Hares feed after sunset or during the night ; rabbits, by day.

The food of the Cottontail is entirely vegetable. He is provided with a double set of upper teeth, which he sometimes uses with destructive effect upon young fruit trees, girdling them completely, and causing them to die. His food in summer consists principally of clover, but he is very fond of cabbage and other vegetables, and makes frequent visits to the farmer's garden. The young are born, generally in the hay-field, in a shallow excavation bedded with dried grass and rabbit fur, and a form of young rabbits makes a very pretty picture indeed. It is interesting to watch the actions of the rabbits in a large field of hay or grain which is being cut. Try to be on hand sometime when the machine is making its final rounds in the centre of the field, and watch what happens.

In the winter the rabbits are active, and subsist on twigs, bark, and dried weeds and grasses. At this season they commonly take refuge in brush piles, or in deserted ground holes. Their track in the snow is easily distinguishable, and is somewhat peculiar, inasmuch as the two

front marks are made by the hind feet. How do you account for this? (See cut.)

Rabbit Footmarks.

When pursued, the Cottontail seldom takes refuge in a ground hole. The brier-bush is his greatest friend, and he is, moreover, an expert runner, and an adept at throwing the pursuer off the trail by all manner of devices. When pursued in the open, however, he has a foolish habit of running in circles, which gives his antagonist the advantage at once. His method of signalling by "thumping" on the ground with his hind foot is well known to all nature students who have had the pleasure of meeting him in his moonlight excursions.

The Northern, or Varying Hare is also found in Canada, but is less common in the southern districts than the Wood Hare. It differs little from the Cottontail, except in its somewhat larger size, and in the fact that it changes color, turning white in the winter season.

4. The Muskrat. Body, $11\frac{1}{2}$ inches; tail, 11 inches. Found in the neighborhood of shallow ponds and sluggish streams.

The Muskrat, so called from the musky odor of a large gland, is about the size of a small rabbit. In color it is dark brown, but the sides are reddish, and the under parts ashy-gray. The hind feet are webbed, like those of a duck, so that they are especially adapted for swimming. The food of the muskrat consists of roots and weeds; he rarely touches flesh or fish, but is fond of clams. During the summer he makes his home in a living room at the end of a tunnel in the bank, the entrance to which is generally under water. Here the young are born in May and July,—three to six at a birth.

Muskrat.

Late in the fall the Muskrat constructs, in the bed of the stream, a cone-like mound resembling a small hay-cock, in the snug interior of which he passes the winter. The entrance to the mound is always under water, and the interior of the living room is well lined with lily leaves and dry weeds. It is said by the weather-wise that a careful observation of the height of the cone and the time of building will enable one to forecast the nature of the winter to follow. If the opportunity presents itself, you will find it interesting to verify or disprove this point for yourselves. The muskrat is active in winter. The coldness of the weather does not affect him to any extent, for his coat is so thick and compact that the water, in which so much of his time is passed, does not penetrate to his skin.

5. The Squirrel.

Four varieties of squirrels are common in Canada—the chipmunk, or ground squirrel, the red squirrel, the flying squirrel, and the black or gray squirrel.

(1) The Chipmunk. Body, 6 inches; tail, 4½ inches. Found among stumps and logs, in partially-cleared land.

The Chipmunk may be easily distinguished from the red squirrel by its smaller size, striped coat, cheek pouches, and smaller tail. The chief use of the bushy tail of the other varieties is that it helps them in leaping from tree to tree and branch to branch. The chipmunk, however, lives almost entirely upon the ground, and the size of its tail is, accordingly, adapted to its different mode of life.

The chipmunk is the most provident of the squirrels. It lives all winter long in its nest under the ground; and in the autumn, before retiring for the winter, it lays by sufficient stores of nuts and acorns to last it for food until the spring. The entrance to the nest is a round hole about an inch in diameter, found generally in the middle of a knoll or ridge. How do you account for the fact that no earth is found around the mouth of the hole? And in this connection,

Chipmunk.

what is there in the chipmunk's mode of living that renders the possession of cheek pouches a necessity?

As may be seen by the snow tracks in early spring, only one chipmunk occupies each burrow during the winter. The young are born in June and August, two to six at a birth. The chipmunk has two calls, a short shrill cry indicative of alarm, and a quiet "chunking" call-note besides.

(2) THE RED SQUIRREL. Body, 7½ inches; tail, 6½ inches. Found in cities, especially in fir trees, and in the country in the open woods.

The Red Squirrel, or Chickaree, is the best known of all the squirrels. This is due partly to his presence in towns and cities, partly to the fact that he is active in winter as well as in summer, but principally to his own boldness and inquisitiveness, which make his scolding and chattering familiar to every one in city and country alike. In winter he lives in a hole in a tree, but in the summer he builds a nest, a big round ball of fine withered grass, in a sapling, usually in the middle of a tangle of wild grape-vines. Make the experiment of putting up a small box, with a hole in one end, in the sapling containing the nest, or in a tree near by, and note the result.

The food of the red squirrel consists principally of nuts, acorns, grain, pine-cones, and other vegetable matter. In the early spring he taps the branches for sap, and late in the season shows a marked partiality for freshly-laid birds' eggs. He lays up a store of nuts for the winter, or buries them in the ground, whence he digs them up when required. If you watch him carefully you will find that, very often, in order to be sure of his harvest of nuts, he cuts them off the tree, lets them fall to the ground, and gathers them up afterwards.

He has several ways of expressing himself. His call-note is a loud monotonous zill-l-l-l-l; while excitement and alarm are indicated by a vigorous chattering, the sound of which is

The Flying Squirrel.

imperfectly imitated in his second name, the "Chickaree." He possesses, with all his boldness and inquisitiveness, a very nervous and excitable nature,—a fact of which you may easily satisfy yourself by drawing his attention to your presence at the foot of the tree, or by whistling a lively tune in his immediate hearing, and noting the effects. The young, three in a litter, are born in May.

(3) THE FLYING SQUIRREL. Body, 6½ inches; tail, 5 inches. Found in the open woods; sometimes also in towns and cities.

The Flying Squirrel is the only member of the squirrel family which is nocturnal in its habits. It sleeps during the day and becomes active about sundown. Although called the flying squirrel, it does not actually fly. Between its fore and hind legs, along its sides, runs a membrane which acts as a parachute to break the fall of the squirrel; while its flattened tail serves the purpose of a rudder. By means of this membrane it is able to sail slantingly from the top of one tree to the foot of another, but it cannot fly from tree-top to tree-top except for short distances. In appearance it resembles the red squirrel more than the other varieties.

The Flying Squirrel makes its nest in a hole in a tree or a stub, and in this nest the young are born in May or June,—four at a birth. There are always two entrances to the nest, to provide for escape in case of attack by a weasel or a snake. Besides this dwelling, he always constructs a moss nest in the fork of a sapling, for use during the summer months. During the winter he goes into hibernation for some time at least, although he is said to store up supplies of food in the fall. Unlike the other varieties, the flying squirrel is gregarious in winter, eight or ten often inhabiting one dwelling. His call or cry is a soft thin note which can be heard only when close at hand.

(4) THE BLACK OR GRAY SQUIRREL. Body, 10½ inches; tail, 10½ inches. Found in the thick woods.

See Section V. of this chapter, for a detailed study.

6. THE FIELD MOUSE.

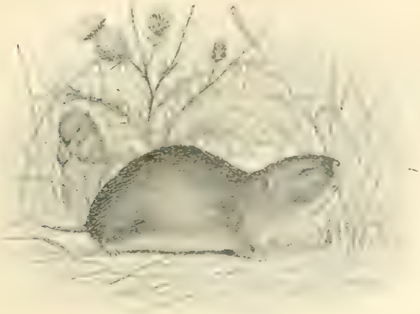
In Canada two varieties of Field Mice are common, the white-footed or deer-mouse, and the meadow-mouse.

(1) THE WHITE-FOOTED MOUSE. Body, 3¼ inches; tail, 3¼ inches. Found in both woods and fields.

The White-footed Mouse is reddish-brown above and white below, and may be readily recognized by its long tail, white feet and sharp nose. It is prettier in appearance well as more interesting in habits, than the meadow-1. It is a great climber and always makes its nest above ground in old stumps, logs, hollow trees, haystacks, and sometimes in deserted birds' nests, which it roofs over snugly for the occasion. In the fall it stores up supplies of grain, corn,

The White-footed Mouse.

acorns, and beech nuts, the latter of which are neatly hulled beforehand. It is active in winter and is mainly responsible for the mice-tracks on the surface of the snow.



The Meadow Mouse.

(2) THE MEADOW-MOUSE. Body, 4½ inches; tail, 1¼ inches. Found in gardens and orchards, and in grain and hay fields.

The Meadow-Mouse is brownish-black in color, and may be readily distinguished by its blunt nose, small eyes, and short tail. It is much coarser in appearance and much more pugnacious in disposition than the delicate deer-mouse. It lives upon grass-stems, herbs, seeds, nuts, roots, and the bark of trees, and is very destructive to young trees and plants. It scratches out a nest, some five or six inches deep, in the ground, and there stores its winter provision. It does not change color in winter, but lives principally beneath the snow, where it builds a warm nest of dried grass. After the snow has nearly melted off in the spring, take a walk across the fields and examine the marks of the runways of the mice, among the grass and stubble. You will find imprinted there more plainly than words can describe it, the full history of their winter life and habits. Both the meadow-mouse and the white-footed mouse sleep during the day and are active only at night. The young are born, four or five in a litter, during the early spring and summer.

III. INSECTIVORA, OR INSECT-EATERS

1. THE MOLE. (*a*) Common Mole. Body, 4½ inches; tail, 1 inch.
(*b*) Star-nosed Mole. Body, 3¾ inches; tail, 3 inches.
Found in lawns and fields.

The Moles live entirely beneath the surface of the earth, and rarely appear above ground. Like most of the Mammals, they are nocturnal in their habits. Sometimes they appear above the surface in rainy weather, or at dusk, and they have a strange habit of coming out precisely at noon. Dead moles, however, are more often seen than living ones; for, contrary to the usual custom of animals, the mole prefers to seek the open rather than go into deeper hiding on the approach of death.

The underground dwelling of the mole is situated under a hillock and consists of a living room bedded with leaves, which is approached by various beaten tunnels and passages. The young are born in spring and autumn, four or five in a litter. The food of the mole consists principally of earthworms and grubs. In search for these it has to dig rapidly

The Mole.

through the soil, and the little corrugations or ridges which mark its course may often be seen on the surface of the ground. An examination of the picture will show how admirably the body of the mole is adapted to its mode of living.

2. The Shrews. Least Shrew. Body, 2½ inches; tail, 1½ inches.

The Shrews, the smallest of the mammals, belong also to the order of insect eaters, and are closely related to the moles. In appearance, however, they resemble small mice. They are found in the woods, and are active in day time as well as at night. They do not burrow to any extent, but secure their food on the surface of the ground.

IV. WING-HANDED MAMMALS

Bats. (*a*) Red Bat. Body, 4 inches; spread of wings, 12 inches.
(*b*) Little Brown Bat. Body, 3½ inches; spread of wings, 10 inches.

The Bat is entirely nocturnal in its habits. It sleeps during the day in some hollow tree, cave, barn, or tower where it will not be disturbed, hooking itself to some projection by its tenacious claws, and hanging head downward. Although it flies it does not possess true wings, but for purposes of flight is provided with a thin membrane stretched between the long fingers or claws of the fore feet, and attached to the sides, hind legs, and tail. The thumbs of the fore feet

The Bat.

are free, and by the help of these claws it can crawl upon the ground when its wings are closed, but its movement is very clumsy. The eyes of the bat, unlike those of the nocturnal flying squirrel, are very small, but the ears are large, and as the membranes of the wings are very sensitive, it is guided in its movements principally by the sense of touch. The food of the bat consists chiefly of flies and gnats, which it catches on the wing.

In winter the bats hibernate; they are gregarious, and gather in large numbers in caves, hollow trees, towers, etc., where they sleep the cold season through, hanging head downward by the claws as they do in the midsummer days. The young are born naked and blind, one or two in a litter.

IV. MAMMALS OF THE PRAIRIES

The following Mammals are peculiar to the prairies of Western Canada, and are not found in the eastern provinces:

1. THE PRAIRIE DOG. Body, 13 inches; tail, 4 inches.

The Prairie Dog is a southern species, and is not found very far north of the southern boundary of Canada. The name "prairie dog" is somewhat misleading, as this mammal does not resemble a dog in any respect except in its cry, a sharp "yap-yap-yap." It belongs to the ground-squirrel family, and lives in deep burrows in the ground. Prairie dogs live in colonies, and their dens are connected with one another, so as to form underground villages, which extend sometimes for twenty or thirty miles. They are vegetable eaters and live upon grass and roots. In the winter they hibernate, like their eastern cousins, the woodchucks.

In the southern prairies the prairie dog is a very familiar figure, as he sits in the sun at the mouth of his burrow. His inquisitiveness is great, and he is always anxious to know all that is going on in the neighborhood of his village.

Prairie Dogs.

On the slightest alarm, however, he disappears into his burrow, only to re-appear a moment later to continue his observations.

2. The Gopher.

Under the name "gopher," are commonly classed two very different species of ground-burrowing mammals.

(1) **The Spermophiles,** or seed eaters. Of the spermophiles three species are found in Canada, the **Gray,** the **Yellow,** and the **Striped Gopher.** They resemble the chipmunk in form and habits, but are slightly larger in size. Like the chipmunk they live in holes in the ground and store up supplies for the winter. The term *spermophile* means "seed-eater"; but, although these gophers live principally upon seeds, they are omnivorous, and will eat fruit, roots, insects, and mice also.

(2) **The Pouched Gophers.** Of the pouched gophers two species are found on the prairies, the **Pocket Gopher,** and the **Mole Gopher.** These gophers resemble the mole in appearance and habits, but, unlike the mole, they are vegetable eaters. Like the chipmunk they are provided with cheek pouches for carrying home their food. As they hibernate in winter, and in summer are nocturnal in their habits, they are seldom seen. They live in burrows in the ground, and, as they are great diggers and throw up large mounds of earth, they are in the highest degree objectionable to the farmer.

3. THE BADGER.

The Badger is about the size of the raccoon or the skunk, but its head and body are much broader and flatter. In general habits it resembles the skunk more than any other animal. It is much less common now than formerly.

4. THE JACK RABBIT.

The Jack-Rabbit, or Prairie Hare, is larger than the cottontail. It is called the Jack or Jackass—Rabbit from its long ears and legs It is very swift of foot and can outstrip the fastest horse in a fair chase.

5. THE JUMPING MOUSE.

The Jumping Mouse is common on the prairies. It is readily distinguished from the other varieties of mice by its smaller body, (3 inches in length), and its long tail, (5 inches in length). Its movements are very graceful, and as it bounds along over the grass it hardly seems to touch the ground. In habits it differs little from the field-mouse, except that it hibernates in the winter.

Besides these five Mammals, certain other varieties are peculiar to the prairies, but they do not require more than bare mention. The Prairie Fox, the Coyote or Prairie Wolf,

and the Antelope, were formerly common, but are now comparatively rare. Among the smaller mammals not found in the eastern provinces, are the Hoary Bat, three varieties of Squirrel, (the Missouri Striped, Say's, and Richardson's), two varieties of Woodchuck, (the Hoary and the Yellow-footed), and seven or eight varieties of Field-Mice. The Black (or Gray) Squirrel is not found in Western Canada. The remainder of the mammals of the west differ very slightly from those of the eastern provinces.

In the Pine Woods.

III. RELATION TO MAN

Most of the Mammals are supplied by nature with effective means of defence. The raccoon and the woodchuck, which are neither of them swift of foot, have provided themselves with natural strongholds. They are, besides, good fighters, and are well able to defend themselves from attack. The skunk possesses an effective weapon in its disagreeable secretion. The rabbit is provided with a swift pair of heels to make good his escape. The muskrat, at the slightest alarm, takes refuge in his den under water, whither few can follow. The squirrels have learned the art of concealing themselves in the tree-tops. The field-mice take refuge in the thick grasses, and the moles are protected by their unpleasant odor; while the bats with their wonderful powers of flight are safe from pursuit.

In addition to these individual qualities, the keenness of scent, the protective coloring, hibernation, and nocturnal habits of most of the mammals, are more or less advantageous to them in their struggle for existence. If left to themselves, most of the wild animals would be able to hold their own, and the balance of nature would be preserved. But the advance of civilization has interfered more or less with the conditions under which wild life exists, and it becomes necessary for us to consider and to regulate our relations with these lower orders of life.

There are very few of the smaller mammals which are not systematically pursued by man, either for the sake of their fur, or for sport, or on account of the antagonism of the farmer to them because of their depredations. It is almost impossible to draw a hard and fast line between those which

merit our protection and those which do not, but it is perhaps well to point out some of the facts which may lead us to a proper conclusion in each individual case.

(1) **The Raccoon,** in Southern Ontario at least, is becoming scarce. The demand for the fur for coats, etc., is largely responsible for this, although the farmer is by no means friendly disposed to the raccoon on account of his occasional visits to the chicken-roost. It is probable,however, that in the destruction of mice he more than repays his occasional levy upon the hen-house. The raccoon is easily tamed, and makes a contented and affectionate, but mischievous, pet. His gradual disappearance from some parts of the country is much to be regretted.

(2) **The Skunk,** in spite of his visits to the chicken-roosts, is one of the most valuable allies of the farmer. He destroys immense numbers of mice, reptiles, grasshoppers, beetles, and injurious insects. When the scent glands are removed, the skunk is an interesting animal in captivity. He is easily domesticated, and affectionate, and no animal is freer from taint, or more cleanly in his habits. There is considerable demand for his fur, which is dyed and put on the market under the name of Alaska Sable.

(3) **The Woodchuck** continues to hold his own in the fields and woods. His presence in the hay field is objectionable more on account of the fact that the holes he makes are dangerous for the horses' feet, than on account of his actual destruction of hay and grass. In captivity the young make intelligent and teachable pets. The fur of the woodchuck is of very little value.

(4) **The Hare, or Rabbit,** is prolific, and, in spite of its destruction by sportsmen, continues to hold its own. The farmer finds it objectionable on account of its destructiveness in the garden, and its habit of girdling and killing young

trees. It thrives in captivity, and, notwithstanding the multitude of its enemies in its wild state, is not likely to decrease in numbers. Its fur is valueless.

(5) **The Muskrat** is destroyed in large numbers every year by trappers, for the sake of its fur, but is still found in considerable numbers. If it does no particular good to the farmer, it does him no serious injury, and it is to be hoped that the picturesque domes of grass which indicate its haunts, will continue to be a common feature of our rivers and ponds.

(6) **The Chipmunk, the Flying Squirrel, and the Black (or Gray) Squirrel** deserve our best efforts for their protection. They are not in any way injurious to the farmers' interests, and, besides doubling the pleasure of a ramble in the woods, they serve a useful purpose in Nature's economy as seed distributors. In captivity, all three make interesting pets, but they are, of course, seen to the best advantage in their native element,—the woods. The black squirrel, like the raccoon, is gradually disappearing from our woods, and every effort should be made to secure his preservation.

The Red Squirrel can have few claims for our protection, beyond his companionship in the woods. He plays havoc very often with the farmers' corn, destroys the eggs and young of many of our most useful birds, and displays unrelenting hostility to the more beautiful black squirrel, whom he has succeeded in banishing entirely from many of his former haunts. The fur of the squirrels is of no value.

(7) **The Field-Mice,** more especially meadow-mice, are the greatest enemies of the farmer. They destroy or carry off immense quantities of grain, and do great damage by girdling young trees. The destruction of the natural enemies of the field-mice,—owls, hawks, skunks, etc.,—is largely responsible for the undesirable increase in their numbers.

(8) **The Mole** does little injury to the farmer, and performs a certain service in the destruction of grubs and insects, and in the opening up of the soil.

(9) **The Bat,** like most insect eaters, is beneficial, and in spite of its disagreeable intrusion into domestic circles at times, is of great service to man.

(10) The destructiveness of the **Weasel** and the **Mink,** not included in the above list, is much in excess of their good qualities, as far as they are known. The fur of these animals is fortunately of considerable market value, and every assistance should be given to the trapper in helping to rid the animal world of enemies so undesirable.

(11) Most of the smaller Mammals found on the prairies are in the highest degree objectionable to the farmer. The **Prairie-Dog** destroys the grass, roots and all, and undermines the ground with its villages. When it has exhausted its supplies in one quarter, it moves on to form new villages and cause fresh ruin elsewhere. The **Spermophile** plays havoc with the farmers' corn and grain. The **Pouched Gopher** is destructive to grain and vegetables ; but besides this, it undermines the ground and destroys the fresh crops by throwing up great quantities of earth. The **Jack-Rabbit** is, perhaps, the most voracious and destructive of all the rodents, and, when not held in check, multiplies very rapidly. The **Jumping Mouse** is comparatively harmless.

The natural enemies of these troublesome pests are the **Fox,** the **Badger,** and the **Coyote;** but the farmer, forgetting his obligations to the larger Mammals, has waged incessant war on them. The inevitable result has followed ; the fox, the badger, and the coyote are fast disappearing from the country, and the farmer is left single-handed to fight his enemies and theirs, the prairie dog, the gopher, and the jack-rabbit.

IV. METHOD OF STUDY

The nature student will find the study of the Mammals in their wild state much more difficult than that of the other forms of life. If wild animals were like plants, of which the structure, habitat, food, etc., may be observed at leisure, animal study would be comparatively easy. But most nature students find, in the first place, that it is almost impossible even to see the wild animal, to say nothing of making a detailed observation of its habits. Indeed, most people are quite unaware of the existence of numerous wild animals in woods with which they are otherwise familiar, and would be surprised, if the earth could yield up her living, to see the varied company who have all the while been the silent spectators of their rambles in the fields and woods.

The wild animal, whose life is one continuous struggle for existence, is at all times on his guard, and an unfamiliar figure in the woods, or the sound of an unfamiliar voice—especially the voice of his arch-enemy, man,—is always a signal for concealment. His eye and ear and nerve are trained to catch the slightest sound or vibration, so that he is aware of the presence of an intruder long before the newcomer is able to see him. Besides this, mother nature has contributed to his safety by so modifying his form and color that to an unpractised eye he is almost indistinguishable from his surroundings. It is not a matter of surprise, therefore, that in our ordinary rambles in the fields and woods, we find only silence and solitude on every hand ; or that if by the purest accident we do get a glimpse of an unfamiliar form, we are, for the moment, so surprised and startled that we are unable to describe with any accuracy the nature and appearance of what we have seen.

Another source of difficulty in the observation of wild animal life lies in the fact that a great many of our common wild animals are active only, or chiefly, at night. If it were possible for us to get a faithful reproduction of the sights and sounds of the woods at a given hour of the night, what different conditions and forms of life it would reveal! On the one hand, the owl from his point of vantage on the projecting stub, straining his great, fierce eyes for the hapless snake or wood-mouse on the ground beneath! Here the graceful flying squirrel, caught in mid-career in his slanting downward flight! In the glimpse of open clearing in the mid-wood, the cottontail rabbit with hind foot uplifted in the act of "thumping" the ground as a signal to his mate! There again, a pair of gray old coons, returning from late festivities in the adjacent cornfield to their hollow tree-top by the gully's edge! Close by the rotting stump in the corner of the wood, the white back and tail-plume of Sir Mephitis Mephitica, the skunk, are plainly visible, as he digs through the ground in search of an escaping mole or meadow-mouse. The woodchuck is walking boldly from burrow to burrow across the open, and hark! was that the distant cry of a fox?

In the day-time the scene is changed, and little can be seen but the chipmunk, or the squirrel, or the woodchuck sitting in the sun at the mouth of his burrow.

Notwithstanding the fact, however, that the observation of the wild animals is a matter of such difficulty, it is possible to learn a great deal about them at first hand by making the very best of unfavorable conditions. It must be borne in mind, in the first place, that absolute silence is the first requisite of animal study. The noise of a gun or the sound of a human voice in the woods, or even the noise of a crackling twig, is an immediate bar to observation. It

follows, as a matter of course, that you are likely to see and hear a great deal more if alone, than if in company with others. In the second place, in order that you may not attract the attention of the animal which you wish to observe, the utmost caution is required in moving from place to place. Indeed, it is very much better that the observer, having selected a favorable point of view, should remain perfectly motionless. Nothing attracts the eye of a wild animal so readily as a moving object, and his curiosity is, on the other hand, almost invariably aroused by the sight of an unfamiliar, motionless form.

As a general thing the nature student will obtain better results by confining his observations in the main to some particular portion of some woods with which he is familiar. He will be surprised to find, in the course of a short time, how many burrows and runways there are among the stumps, fences, and roots of trees, which at first escaped his observation entirely. It is an easy matter to ascertain whether a particular ground hole is occupied or not, by covering the mouth of it lightly with grass or weeds, and watching to see whether, in the course of the few days following, it has been disturbed. Experiments may also be made by placing different varieties of food—corn, nuts, apples, cabbage, meat, etc., in various parts of the woods or fields, to determine the presence or absence of certain animals.

But, besides what can be learned from direct observation, there is a great deal that can be gathered from circumstantial evidence. The shell of a walnut that has been filed by a red squirrel, the little bunch of dried grass that has been gathered by a field-mouse, the ridge of soft earth that has been thrown up by a mole, or the mound built by the muskrat in the stream for his winter dwelling, are, each and all, evidence of the kind of life that the various wild animals

lead. It is, however, in winter time that the most information can be gained indirectly regarding their various ways of living. The snow is a great revealer of secrets, and the marks on its surface are indisputable evidence of the habits and actions of the wild animals. We are able to learn from it the nature and duration of the winter sleep of the chipmunk, the skunk, the raccoon and the woodchuck; while the squirrel, the rabbit, and field-mouse, on the other hand, whether at play or in search of food, leave, with every mark they make in the snow, at least a temporary record of their round of daily life.

A whole tragedy, for example, was written in that foot of crushed and beaten snow which I came across, one January morning a few winters ago. Only a foot of crushed and beaten snow, but the scene of a death struggle and death agony nevertheless, in all respects proved and confirmed by indisputable evidence. A few feet away I noticed the marks of a preliminary struggle, and the indentation of wing feathers in the snow. But, apart from these confirmatory signs, I knew that the attacking party belonged to the feathered tribe, for I found, leading up to the final blood-stained circle in the snow, only a single track,—that of a rabbit. I noticed particularly the last three leaps; the very distance was eloquent of despair. Which party was victorious? There was not a feather or a hair,—only some few, faint tinges of blood, and the snow packed hard. But the rabbit-tracks went no further!

From what has been said it will be evident that in our public schools very little object-teaching concerning the Mammals is possible; for, aside from the squirrel, woodchuck, rabbit and field-mouse, the children in most districts are unfamiliar with the appearance of the wild animals. By means of pictures and stories, however, much can be

done to interest the pupils, and the teacher can at least impress upon them the necessity of quiet and cautious movement and absolute silence in observation, and can encourage them to observe and interpret for themselves the circumstantial evidence which may come in their way. The use of firearms by boys should be discouraged, and the spirit which leads children, boys especially, to destroy wild life whenever they see it, should be repressed in every possible way. The interest of observation should be excited to such an extent that it will supplant the instinct of destruction.

A detailed study of any one of the Mammals would occupy much more space than we have at our disposal in a manual such as this. The following outline of the characteristics of the black squirrel, although it does not by any means give a complete account of the habits of the species, may, however, serve the same purpose as an extended study, in as far as it indicates the width of the field to be covered in each case, and the necessity for accuracy and detail in observation.

Summer Shelter.

V. STUDY OF THE BLACK (OR GRAY) SQUIRREL

"The Gray [or Black] Squirrel is peculiarly an American product, and might serve very well as a national emblem."—*John Burroughs.*

There is a shady corner of a certain big beech wood to which I will lead you, where, if you will sit motionless on a fallen log and keep very quiet, you may watch the black squirrels in their native haunts. In this wood nearly all the squirrels are black, but the color of their coat is not an important matter after all, as the pair of gray squirrels across the ravine yonder are identical in all respects with the black, except that they are dressed in the gray suit which the squirrels farther south generally wear instead of the northern black.

For the first five minutes, or perhaps longer, there is absolute silence in the wood. But I know that in the tall hickory yonder, Bush, the black squirrel, whom we interrupted in his evening meal, is lying in hiding. If you knew the exact spot to which to turn your field-glasses, and if the trunk of the tree were not in your way, you would see him crouched close in the crotch, with his body pressed tight against the trunk. And if you went around the tree, you would find that he would shift around the trunk also, to keep the tree or the branch, if possible, between yourself and him.

Bush trusts to his ears more than anything else, and his eyes are very keen for moving things; so you must not make the slightest sound, or even move your head to one side, if you wish to see him. Hark! there he is now! He is sure you have gone at last, and here he comes out to the end of this crooked limb in search of another nut. When he finds one he runs back at once, for safety's sake, to the trunk of the tree to eat it, and if you watch him closely through the field-glasses you will see what an interesting process it

is. He first smells it all over to see if it is good, then turns it right side up and files a little hole in the end. Now he has jerked it neatly in two with his teeth, and is enjoying the meat. His teeth are very strong and he breaks the shell into little bits as he goes along, and flicks them out to one side with his tongue. Now he is smelling the branch of the tree to see if any little morsel has dropped, and the next moment he comes shambling spirally down the trunk to investigate the ground at the bottom.

Do you think that he will notice the yellow apple that I left lying among the roots for him when we came into the wood? He cannot distinguish colors very well; but bright things catch

The Black Squirrel.

his eye, and he is sure to notice it if he goes to that side. Now he sees it, but he is not sure of what it is. You can always tell when he is excited or alarmed, by the way he waves his big bushy tail ; it is a regular flag of distress. If you watch what he does with the apple you will learn a valuable lesson about the way to prepare your food, for, as you will notice, he never eats the paring or skin, but throws it out to one side too.

He appears to be pretty well satisfied now ; but what can he be going to do with that nut, unless he intends to eat it? Watch him! There he goes up close to the roots of the tree, and see! He has dug out a little hole in the ground with his paws and has buried the nut in it; and there again, a foot or two away, he is burying another. This is the way he puts by his winter supply, and when the cold winter comes and the snow lies deep, he will come back and, one by one, dig the nuts up,—though how he remembers exactly the places where they were hidden, is a mystery to every one who knows the ways of the squirrels. Sometimes when he is desperately hungry he tries to steal from the stores of the red squirrel, but this invariably gets him into trouble, for the red squirrel is a first-class fighter in spite of his size, and Bush is generally very glad to make a shield out of his big tail-brush, and considers himself fortunate if he is able to reach home in safety.

The nut-hiding is rather dirty work, and Bush soon concludes that it is time to stop for the night ; for all squirrels, except the flying squirrel, must be safe in bed at dark. So he licks off his paws first to make them clean, and then gives his face and whiskers a good brushing. See there! Did you ever see anything quite so comical in the squirrel world? What is he doing but using his big bushy tail for a table-napkin and face-brush! Now he is quite clean and tidy, and makes a very pretty picture indeed, as he sits there with

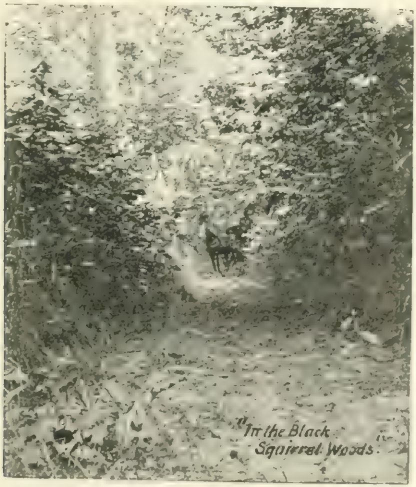
his paws across his breast, listening to see if all is well in the high woods before he starts for home,

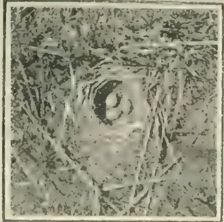
Now he is off at last, and even with your eyes closed you can follow him on his course by the sound of the crashing boughs as he leaps from tree to tree. The big tail, indispensable in so many ways, was never of more real service than it is now, for it is the rudder which steers him as he takes the dizzy leap, and the parachute which keeps him from falling to the ground below. How does he know which branch to take to lead him to the next tree? That is a mystery to some people, but to Bush it is quite clear; for if he has gone by a certain road once, he remembers it perfectly ever afterwards, and he always goes by exactly the same tree-path when he has occasion to go that way again.

Come, and I will show you his hole in the beech tree. There it is yonder, high up in the hollow trunk. He doesn't live there always though, for when house-cleaning is necessary he simply moves to another hole to save unnecessary trouble. Next week he will very likely commence his twig house in the branches; for when the leaves fall off and the branches are bare, he is quite unprotected, and to provide against danger he builds a big, rough bundle of dry leaves and twigs, and takes shelter in the middle of it when it is impossible for him to reach his hole in the beech tree in safety. A black squirrel, like all other animals, has enemies of his own, silent and stealthy all of them, from the hawk, or the weasel, or the snake, to the gun of the unseen hunter crouching in the undergrowth below; and a quick eye, fleet foot, and a shelter near at hand, are the price of life.

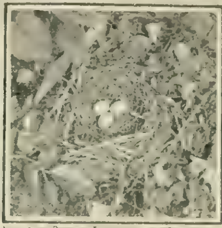
I wish you could come back with me for an hour or two next spring. Bush's old coat gets pretty shabby in the winter and begins to show white patches; but early in the spring he gets a fine, new, glossy suit and looks very pretty

indeed. He needs some consolation of this kind, to be sure, for in these early spring days he is not treated very kindly at home. In March, when his first family of five little black kittens is born, Bush is turned out of doors by his squirrel-wife, who is not very certain of Bush's good intentions towards the newcomers. But, after all, he doesn't care a great deal, for spring has come; the tanagers and the grosbeaks are singing once more in the beech woods; morning and evening he feasts on the maple "keys" and dandelions in the wood, and all day long he basks in the delicious sunshine, dreaming of the golden days to come, when the mushrooms will be white and tender, and the corn will be ripe in the autumn cornfields.

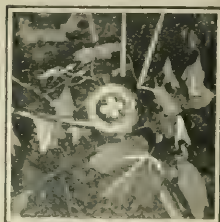

"In the Black Squirrel Woods."



NEST OF HORNED LARK IN THE STUBBLE,
EGGS, CLAY COLOR.

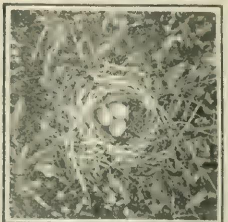


NEST OF BROWN THRASHER, UNDER A BUSH,
EGGS, GREENISH WHITE, SPOTTED BROWN.

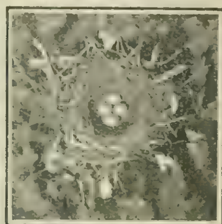


NEST OF LEAST FLYCATCHER, IN A SAPLING, EGGS, WHITE.

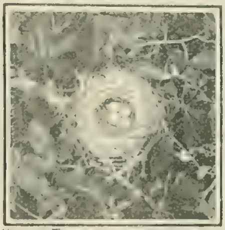
NEST OF PHOEBE, ON RAFTER OF A SHED,
EGGS, PURE WHITE, SAME NEST USED YEARLY.



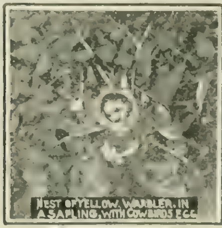
NEST OF CUCKOO IN A HAWTHORN BUSH,
EGGS, LIGHT BLUE.



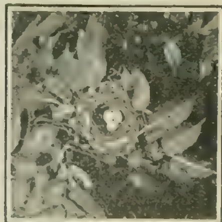
NEST OF CATBIRD, IN A HAWTHORN BUSH,
EGGS, DEEP GREEN.



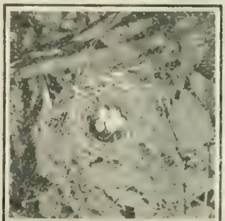
NEST OF TANAGER IN A BEECH TREE,
EGGS, GREENISH BLUE, SPOTTED BROWN.



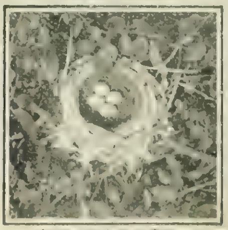
NEST OF YELLOW WARBLER, IN A SAPLING, WITH COWBIRDS EGG
EGGS, GREENISH WHITE,
SPOTTED WITH BROWN.



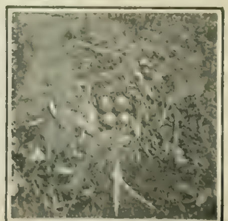
NEST OF INDIGO BIRD, IN A LOW SHRUB.
EGGS, VERY PALE BLUE.



NEST OF SONG SPARROW ON THE GROUND, EGGS, GRAYISH WHITE,
SPOTTED WITH REDDISH BROWN.



NEST OF WOOD THRUSH.
IN A SAPLING, EGGS, BLUE.



NEST OF SPOTTED SANDPIPER.
IN THE SAND, EGGS, CLAY COLOR,
BLOTCHED WITH BROWN.

THE STUDY OF BIRDS

"The busy nuthatch climbs his tree
Around the great bole spirally,

Peeping into wrinkles gray,
Under ruffled lichens gay,

Lazily piping one sharp note
From his silver-mailed throat;

And down the wind the catbird's song
A slender medley trails along.

Here a grackle chirping low;
There a crested vireo;

Every tongue of Nature sings,
The air is palpitant with wings!"

—*Maurice Thompson.*

I. THE FIELD OF STUDY

Birds stand next to mammals in the order of intelligence. They differ from them, of course, in many respects; but chiefly in their adaptation to the air, in their life of greater activity, in the absence of the power of keen scent, and in their relation to their young. Though they do not stand quite so high as the mammals in power of intelligence, they possess, on the other hand, a greater capacity for enjoyment; and their association with light, cheerfulness, and beauty, renders the study of them in the highest degree interesting and attractive.

The birds of North America are divided into seventeen different orders, comprising sixty-seven families, in all. Of these, we have in Ontario, which may be considered a representative Province, fourteen orders, comprising forty-eight families, and including about three hundred and fifteen species. For the sake of convenience, these different orders may be roughly divided into three groups :—

I. Game, Shore, and Water Birds.
II. Birds of Prey.
III. Land Birds.

The first group comprises ten different orders, which are sub-divided into twenty-seven families. We have in the Dominion more than three hundred species belonging to this group. For the sake of convenience they may be roughly classified as follows :—

1. Diving Birds—Including Grebes, Loons, Auks, Murres, and Puffins.
2. Swimmers—Including Skuas, Jaegers, Gulls, Terns, Gannets, Cormorants, Pelicans, Ducks, Geese, and Swans.
3. Waders—Including Herons, Storks, Ibises, Bitterns, Cranes, Rails, etc.
4. Shore Birds—Including Phalaropes, Avocets, Stilts, Snipes, Sandpipers, Plovers, Surf Birds, Turnstones, etc.
5. Gallinaceous Birds—Including Grouse, Partridge, Pheasants, Turkeys, etc.
6. Pigeons—Including Pigeons and Doves.

The second group, Birds of Prey, includes two families :—

(1) Hawks, Eagles, etc.
(2) Owls.

The third group includes, in all, nearly two hundred species, and comprises four orders, which are subdivided into families, as follows :—

I. Order, Coccyges :—

(1) Cuckoos.
(2) Kingfishers.

II. Order, Pici :—

(1) Woodpeckers.

III. Order, Macrochires :—

(1) Goatsuckers.
(2) Swifts.
(3) Humming Birds.

IV. Order, Passeres, Perching Birds :—

(1) Flycatchers.
(2) Larks.
(3) Crows and Jays.
(4) Blackbirds, Orioles, etc.
(5) Sparrows, Finches, etc.
(6) Tanagers.
(7) Swallows.
(8) Waxwings.
(9) Shrikes.
(10) Vireos.
(11) Warblers.
(12) Wrens and Thrashers.
(13) Creepers.
(14) Nuthatches.
(15) Wagtails.
(16) Kinglets and Gnat-catchers.
(17) Thrushes and Bluebirds.

It will be evident from a glance at this array of families, that even the mere recognition of the birds will be no easy task to the beginner in Nature-study. But recognition is, after all, only the first step in making their acquaintance. The bird-lover must make himself familiar with their language. their songs and calls, their haunts, their habitats, their nesting habits, their eggs, their food, their relation to agriculture, their adaptation to their surroundings, their changes in form and

plumage, their social habits, their migrations and the laws that govern them, and the variety of instincts which have resulted in particular actions and habits.

The aim of the bird-student must be three-fold, to increase his own knowledge of birds, thereby introducing into his life an additional element of pleasure, to enlist the interest and sympathy of others so as to secure like results, and to do all in his power to secure the protection of the birds where a study of their food and habits proves them to be beneficial and desirable.

"Forth into the forest straightway
All alone walked Hiawatha
Proudly, with his bow and arrows ;
And the birds sang round him, o'er him,
'Do not shoot us, Hiawatha !'
Sang the Robin, the Opechee,
Sang the Bluebird, the Owaissa,
'Do not shoot us, Hiawatha !'
Up the oak tree, close beside him,
Sprang the Squirrel, Adjidaumo,
In and out among the branches,
Coughed and chattered from the oak tree,
Laughed, and said between his laughing,
'Do not shoot me, Hiawatha !'
And the Rabbit from his pathway
Leaped aside, and at a distance
Sat erect upon his haunches,
Half in fear and half in frolic,
Saying to the little hunter,
'Do not shoot me, Hiawatha !' "

—*Longfellow.*

II. RECOGNITION OF THE BIRDS

In the recognition of birds, especially in the distinction between members of the same family, the bird-student must have recourse to a field color-key, or to the detailed technical descriptions found in the standard books on birds. But some assistance may be given to the beginner by directing his attention to some of the most marked lines of distinction between the different families and species.

Besides being classified according to relationship, birds may be grouped according to period of residence, migration, haunts, size, etc. The lists given in the following paragraphs contain only the names of the common land birds in each group, and are intended simply as a guide to the beginner. The conditions of bird-life vary, of course, for different localities, and the student must, in almost all cases, compile statistics for his own district, from direct observation.

I. Period of Residence. The two following groups of birds should be noted :—

1. Winter Birds :—

(1)	Snowflake.	Tree Sparrow.
	Golden-crowned Kinglet.	Red-bellied Woodpecker.
(2)	Junco.	Chickadee.
(3)	Cedar Waxwing.	Downy Woodpecker.
	Blue Jay.	Hairy "
	Horned Lark.	English Sparrow.
	Nuthatch.	Screech Owl.

(4) Bohemian Waxwing.	Redpoll.
Pine Grosbeak.	Lapland Longspur.
Crossbill.	Pine Siskin.

Birds in (1) are found only in winter; in (2) are rare in summer; in (3) are common in both seasons; in (4) are rare winter visitors.

2. Migrants, found only in Spring and Fall :—

Ruby-crowned Kinglet.	Rusty Blackbird.
Yellow-bellied Sapsucker.	White-crowned Sparrow.
Red-breasted Nuthatch.	White-throated Sparrow.
Hermit Thrush.	Most of the Warblers.

II. Return in Spring. The following birds may be easily distinguished from the other species, as they return in March :—

Crow.	Horned Lark.	Phœbe.
Robin.	Bronzed Grackle.	Cowbird.
Bluebird.	Red-winged Blackbird.	Kingfisher.
Song Sparrow.	Meadowlark.	Mourning Dove.

III. Haunts. No hard and fast line can be drawn regarding the haunts of many of the birds, but the following are characteristic groups :—

(1) The Woods :—

Crow.	Nuthatch.	Oven Bird.
Hawk.	Grosbeak.	Pewee.
Owl.	Tanager.	Red-eyed Vireo.
Woodpecker.	Wood Thrush.	

(2) The Thickets :—

Catbird.	Towhee.	Indigo Bird.
Brown Thrasher.	Cuckoo.	Redstart.
Wilson's Thrush.	Field Sparrow.	

Song Sparrow.
Horned Lark.
APRIL. EARLY SPRING MUSIC.

(3) The Field :—

Bobolink.	Meadowlark.
Horned Lark.	Vesper Sparrow.

(4) Orchard and Barn :—

Kingbird.	Least Flycatcher.	Phœbe.
Bluebird.	Butcher Bird.	Barn Swallow.
Chipping Sparrow.	Wren.	Cliff Swallow.
Robin.		

(5) City :—

English Sparrow.	Mourning Dove.	Warbling Vireo.
Blue Jay.	Bronzed Grackle.	Yellow Warbler.
Oriole.	Nighthawk.	Chimney Swift.
Goldfinch.	Waxwing.	Purple Martin.

(6) River Side :—

Red-winged Blackbird.	Spotted Sandpiper.
Bank Swallow.	Killdeer.
Kingfisher.	

IV. The following will be easily distinguished from other birds by their smaller size :—

Humming Bird.	Redstart.	Chickadee.
Indigo Bird.	Vireo.	Kinglets.
Nuthatch.	Least Flycatcher.	Yellow Warbler.
Wren.	Brown Creeper.	

V. Song. Certain birds are sure to attract attention by the superior quality of their song, as for example :

Brown Thrasher.	Rose-breasted Grosbeak.
Catbird.	Wood Thrush.
Bobolink.	Wilson's Thrush, or Veery

VI. Nest. The location of the nest affords some clue to the identity of the bird. The following should be noted :—

1. In Holes, in Trees or Stubs :—

Bluebird.	Woodpecker.	Owl.
Chickadee.	Nuthatch.	Crested Flycatcher.
Wren.	Sparrow Hawk.	Tree Swallow.

2. On the Ground, or near it :—

Horned Lark.	Bobolink.	Red-winged Blackbird
Meadowlark.	Brown Thrasher.	Indigo Bird.
Vesper Sparrow.	Towhee.	Song Sparrow.
Wilson's Thrush.	Oven Bird.	Sandpiper.

In addition to the above rough classification, the following comments on the individual families may be of assistance to the beginner.

I. GAME, SHORE, AND WATER BIRDS

1. **Diving Birds:**—

(*a*) **The Grebes** are especially interesting on account of their nesting habits. The nests are found among the rushes and reeds at the edges of ponds and rivers. The Grebe incubates the eggs only at night, and during the day they are concealed by a covering of rushes and weeds. The Grebes are, in general, rare in Eastern Canada, but abundant in the West. The Pie-billed Grebe, also known as Dabchick, and Hell-diver, is, perhaps, the most widely distributed of the five species found in Canada.

(*b*) For a study of **The Loon,** see Long's *Wilderness Ways*, or Thoreau's *Walden*.

2. **Swimmers:**—

(*a*) **Gulls.** In Canada, we have over twenty species of

gulls. The most widely distributed species is the American Herring Gull, which breeds throughout the whole Dominion. Hundreds of these gulls are always seen following in the wake of lake vessels or hovering about the wharves in search of the offal upon which they feed. They have been called the scavengers of the lakes, and are entitled to every protection.

(*b*) **Ducks.** Over thirty-five species of ducks are found in Canada. Of these the most common are, the Merganser, the Ruddy Duck, the Old Squaw, the Lesser Scaup Duck, the Canvas-back, the Red-head, the Wood Duck, the Pintail, the Spoonbill, the Teal, the Baldpate, the Mallard, and the Black Duck.

An interesting study of the Merganser is to be found in Long's *Ways of Wood Folk.* The Old Squaw is a sea duck, common on the Atlantic coast, and in the St. Lawrence. The Black Duck is the common wild duck of the Maritime Provinces. See *Ways of Wood Folk* for a study of this species also. The Canvas-back and the Red-head are so closely related that it is almost impossible to distinguish the one from the other. With the exception of the Old Squaw and the Black Duck, all these species are very abundant in Western Canada. The Mallard, though not common in the Maritime Provinces, is the most abundant duck in the North-West Territories and British Columbia.

3. **Waders.** The most widely distributed of the Waders are the American Bittern, the Great Blue Heron, the Virginia Rail, and the Sora Rail. These different species are found breeding in all of the provinces, but are most abundant in Western Canada.

4. **Shore Birds.** We have about sixty species of Shore Birds in Canada. Perhaps the best known of all are the

American Woodcock, the Wilson's Snipe, the Spotted Sandpiper, and the Killdeer Plover. The Woodcock is found only in Eastern Canada, and the Killdeer is abundant only from Ontario westward. Six or seven other species of Shore Birds are very common in Western Canada, but these species are very rare in the Eastern Provinces,—Wilson's Phalarope, the American Avocet, the Longbilled Dowitcher, Baird's Sandpiper, the Western Willet, etc.

5. **Gallinaceous Birds.** The Ruffed Grouse, or "Partridge," is an abundant resident in Ontario, Quebec and the Maritime Provinces. For a detailed study of the Partridge see the story of "Redruff" in *Wild Animals I Have Known.*

In Western Canada the place of the Partridge is taken by two different species, the Pinnated Grouse and the Sharp-tailed Grouse, or "Prairie Chicken." The Pinnated Grouse, sometimes known as the "Prairie Hen," is found only along a part of the southern boundary of the Dominion. Of the Sharp-tailed Grouse there are two varieties, the "Prairie Chicken" the partridge of the plains, and the Columbian Sharp-tailed Grouse, which frequents the copses and thickets.

The "Bob White" Quail is found only in Southern Ontario.

6. **Pigeons.** The Mourning Dove is widely distributed, but is nowhere common, except, perhaps, in south-western Ontario. The Passenger Pigeon, formerly abundant, is rapidly becoming extinct.

II. BIRDS OF PREY

1. **Hawks.** Note especially the three Hawk groups:—

   (*a*) The Sparrow Hawk.

   (*b*) The Sharp-shinned Hawk.
   Cooper's Hawk.

   (*c*) The Red-shouldered Hawk.
   The Red-tailed Hawk.

The Sparrow Hawk is small, not much larger than the Blue-Jay, and the markings of the male and female are quite different. The two hawks in (*b*), and the two in (*c*) resemble each other closely. The Red-shouldered Hawk is the largest of the family, and may be readily distinguished by its slow flight and its loud, harsh call, *kee-you*, *kee-you*.

2. **Owls.** The commonest species of Owl in Canada is the Screech Owl. In the various stuffed specimens that you see you will probably notice considerable variation in color, for the Screech Owl appears at different times in coats of different colors, ranging from blackish-grey to rusty-red. These various phases of color do not appear to be governed by age, sex, locality or season, and no satisfactory reason for them has yet been given. Besides the familiar "screech" of the owl, you may, perhaps, have the privilege, some time, of listening to his liquid, quavering song as it is borne across the fields from the woods, in the growing twilight of an early spring day.

III. LAND BIRDS

1. **Cuckoos.** Note the differences in the eyes, and in the bills of the two American Cuckoos. During June and July the loud, harsh call of the Cuckoo, *ku*, *ku*, *ku*, *ku*, *kow-kow kow*, is one of the familiar sounds of the riverside thickets. Besides this call, however, he has a regular "cuckoo" song. Watch his contortions while he is singing ; you will be well repaid. The Cuckoo does not nest until late in June. The nest is a very flimsy structure and is generally placed in a thorn bush in the neighborhood of a stream. When you find the nest, after due observation decide the following points for yourself. Is there any regularity in the times at which the eggs are laid ? Is the Cuckoo ever guilty of nest desertion ? What is peculiar in the appearance of the young Cuckoos ? Among the farmers the Cuckoo goes by the name of "rain-

bird," from the popular belief that his call denotes rain. Is there any truth in the superstition?

2. **Kingfishers.** The Kingfishers lay their eggs at the end of a tunnel dug six or eight feet into the bank of a lake or stream. Suggest a reason for this choice of a nesting place. Explain the name *Kingfisher* as applied to this bird.

3. **Woodpeckers.** We have five common species of Woodpecker in Canada, the Downy, Hairy, Flicker, Red-headed, and Red-beliied. The Downy and the Hairy differ principally in size, the Downy being the smaller. Which do you find the more sociable of the two? Notice the scarlet crown-patch on the males. The Flicker, so called from its song, is also known as the Golden-winged Woodpecker, the Highhole, and the Yellow-hammer. Are its habits undergoing a change? Read Chapter XI. in Long's *Ways of Wood Folk.* The Red-bellied Woodpecker, a winter bird, is the most beautiful of all the woodpeckers. It is found principally in southern Ontario.

4. **Goatsuckers.** This family includes the Nighthawk, and the Whip-poor-will. The name, Goatsucker, is a survival of an ignorant belief. Can you give an explanation of the sound made by the Nighthawk? What are the points of distinction between the Nighthawk and the Whip-poor-will?

5. **Swifts.** The Chimney Swift is more active at night than in the day. It may be distinguished from the swallows, when on the wing, by its short blunt tail, and by the fact that it never perches. From the fact that it makes its nest in chimneys what would you suppose to have been its nesting place before the advent of the white man?

6. **Humming Birds.** What causes the humming sound? What purpose does the long slender bill serve? Note the

Downy Woodpecker. Flicker.

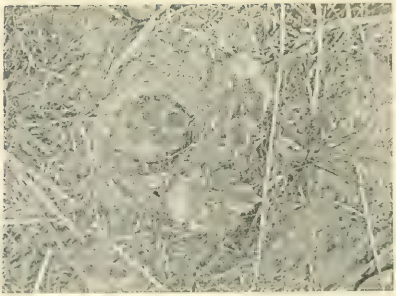
WOODLAND ECHOES.

beauty of the Humming Bird's nest ! Only one species, the Ruby-throated Humming Bird, is found in Canada.

7. **Flycatchers.** We have five common species of Flycatchers in Canada :—the Crested Flycatcher, the Kingbird, the Phoebe, the Pewee, and the Least Flycatcher. The Crested, easily recognized by its loud, harsh call, nests in a hole in a stub. At the entrance of the cavity it always places a piece of cast-off snake skin. Suggest a reason for this strange habit. The Phoebe nests in barns, in sheds, or under bridges. The names *Phoebe* and *Pewee* are imitative of the call of these birds. The Least Flycatcher expresses himself by a short, harsh *Chebec*. The female of this species is very friendly and may be observed at arm's length. Note for yourself the dates of the return of the various Flycatchers. How do you account for the extreme lateness of the Pewee? If you are awake at daylight on a June morning you will notice how different the Pewee's song is from his usual mournful strain. Can you explain why the Flycatchers have neither gifts of song nor brilliancy of plumage?

8. **Larks.** There are two species of Horned Larks, the Horned Lark proper, and the Prairie Horned Lark, differing only very slightly from each other. It is claimed that the species found in southern Canada in winter is the Horned Lark proper, and that our common summer species is the Prairie Horned Lark. In winter the Horned Lark keeps company with the Snowflakes, and in March, flocks of these birds are very abundant in the bare open fields.

The Horned Lark is the earliest of the small birds to nest in the spring. Any time after the first of April you may begin your search for the nest, among the stubble. It is very difficult to find, however, and it is only after a close observation of the movements of the parent birds that it is



Young Larks and Nest, showing Protective Coloration.

possible to succeed. The song of the Horned Lark is a frosty, spring-like gurgle; but sometimes in the breeding season he sings from a point high in the air, after the fashion of the English Skylark.

9. **Crows and Jays.** "The Crow is nothing but a fox in feathers," and the Blue Jay is his first cousin. The Crow nests in April, about the time that the first buds appear on the trees. He does not build a nest every year, but repairs the old one and makes use of it for as many seasons as possible. To find out whether the bundle of twigs in the crotch of a tree is occupied by Mother Crow or not, hammer on the trunk of the tree with a stout stick, and watch developments. Long's and Seton-Thompson's stories of the Crow contain interesting accounts of the habits and peculiarities of the species.

Besides the harsh call of the Jay, notice his song, a musical *too loo loo*, heard principally during the breeding season

"The pillow of this daring head
Is pungent evergreens ;
His larder— terse and militant
Unknown, refreshing things ;

His character a tonic,
His future a dispute ;
Unfair an immortality
That leaves this neighbor out.

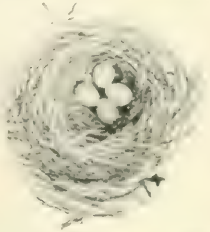
10. **Blackbirds, Orioles, etc.** This family includes among others, the Bobolink, Cowbird, Red-winged Blackbird, Meadowlark, Orchard Oriole, Baltimore Oriole, Rusty Blackbird, and Bronzed Grackle.

The acquaintance of the Bobolink may be made in June in the neighborhood of almost any clover field, but it will tax your utmost ingenuity to find the nest.

The Bobolink is a favorite with the poets. The following is the last stanza of *The O'Lincoln Family* by Wilson Flagg:—

"Every one's a funny fellow; every one's a little mellow;
Follow, follow, follow, follow, o'er the hill and in the hollow!
Merrily, merrily, there they hie; now they rise and now they fly;
They cross and turn, and in and out, and down in the middle, and wheel about—
With a 'phew, shew, Wadolincoln! listen to me, Bobolincoln!
Happy's the wooing that's speedily doing, that's speedily doing,
That's merry and over with the bloom of the clover!
Bobolincoln, Wadolincoln, Winterseeble, follow, follow me!"

The Cowbird can be recognized immediately by his brown head, and wherever found should be destroyed. The female lacks the brown of the head but is distinguished by a dirty, grayish-black coat. The Cowbird is the parasite of American birds, corresponding in habits to the European Cuckoo. It builds no nest, but lays its eggs in the nests of smaller birds. The egg of the Cowbird hatches out sooner than the others and the big Cowbird fledgling soon crowds the weaker birds out of the nest. Besides this, to make sure of the success of the imposition, the old Cowbird often destroys the other eggs in the nest by pricking them with her bill. Sometimes, however, the quick-witted owner of the nest discovers the deception and covers the objectionable egg over



Bluebird's Nest with three Cowbird's Eggs.

by building a new bottom in the nest. Some idea of the damage done by the Cowbird may be formed if we remember that there is scarcely a nest of the smaller song-birds which does not suffer, to some extent at least, from it. In connection with the Cowbird a number of questions will at once suggest themselves to the bird student. Does the Cowbird perform any service to the bird world in return for its imposition? Under what conditions are the eggs laid? Etc.

The Red-winged Blackbird builds its nest among the reeds or rushes of the marsh. Why has it selected this location? Try to count the number of different call-notes which it makes use of in the nesting season, and interpret them. The charm of its spring song will be doubled if you hear it close at hand.

The Meadowlark has been wrongly named a lark. It belongs in reality to the Blackbird family. Try to distinguish its three different notes. Do you consider its song musical? What is peculiar about its flight? What means has it taken to protect its nest? You will find the latter in a tussock of last year's grass in the pasture field.

The Orchard Oriole and the Baltimore Oriole can never be confused. The latter is orange and black—the colors of Lord Baltimore, whence its name; the Orchard Oriole is deep brown or chestnut, instead of orange. Besides, the latter is rare in Canada, while the Baltimore Oriole is abundant. Watch the Oriole weaving its nest. Where does it get the material? If a Yellow Warbler or a Least Flycatcher happens to be out in search of string at the same time, you may see some interesting developments if you watch the nest closely. What are the advantages of the location of the nest? The following lines from Edgar Fawcett contain a poetic fancy regarding the brilliancy of the Oriole's plumage:

Baltimore Oriole. Rose-breasted Grosbeak.
JUNE—CITY AND COUNTRY

"How falls it, Oriole, thou hast come to fly
In tropic splendor through our northern sky?

At some glad moment was it Nature's choice
To dower a scrap of sunset with a voice?

Or did some orange tulip, flaked with black,
In some forgotten garden, ages back,

Yearning towards heaven until its wish was heard,
Desire unspeakably to be a bird?"

The Rusty Blackbird is a migrant, seen only in spring and fall. The Bronzed Grackle is common in the city as well as in the country, and builds generally in the top of tall spruce trees. Observe the movement of his tail when he sings!

11. **Sparrows, Finches, etc.** Over thirty members of this family are found in Canada. The list includes most of our winter visitors, a number of migrants, and some rare summer residents. The common summer residents are the Rose-breasted Grosbeak, Indigo Bunting, Towhee, Goldfinch, and the House, Field, Chipping, Vesper, and Song Sparrows.

The Rose-breasted Grosbeak is generally found in company with his cousins, the Tanagers, in the moist beech woods. His song in the breeding season is a regular orchestral grand march. Male and female take turns in brooding. If you molest them they will almost invariably destroy the eggs and desert the nest after you have gone.

The Indigo Bird is generally found in a wild raspberry patch. Notice the difference between male and female in plumage.

The Towhee resembles the Robin very much in appearance. His favorite haunts are the thickets and underbrush. The Indigo Bird and the Towhee are found only in southern Ontario.

The Goldfinch, or Wild Canary, does not nest until July; the nest is composed almost entirely of thistle down. What is peculiar about its flight?

The Chipping Sparrow may be recognized by his "chipping" note and by his chestnut crown-patch. The nest is a neat, horsehair structure, found generally among the evergreens.

The Field Sparrow is found among the copses at the outskirts of the woods. His song is a sweet little ditty, unmistakable to those who have once heard it. It might be represented by a series of dashes as follows : — — — - - - - - - - . . .

The Vesper Sparrow is a bird of the roadsides and fences. As you walk along the road it has a fashion of running along the ground ahead of you. It may be distinguished by its white tail feathers. Its song is like that of the Song Sparrow, but is longer and more complicated.

The Song Sparrow supplies the first sweet music of spring. It is "the little bird that sings two or three notes so demurely and then forgets itself." It is partial to low bushes and brush piles. It can always be recognized by its alto call-note, and by the brown spot in the centre of its breast.

The Tree Sparrows and the Juncos, the latter of which are sometimes known as Snow-birds, are common in southern Canada from October to March, and are generally found in company with one another. The Tree Sparrow resembles the Chipping Sparrow in having a chestnut crown-patch, and the Song Sparrow in having a blotch on the breast. In springtime, the Junco is often found in the woods where the winter choppers have been at work. His slate-colored coat, white underparts, and white tail feathers are sure marks of identification.

12. **Tanagers.** The Scarlet Tanager, or Soldier Bird, is generally to be found in the moist beech woods in company with the Grosbeaks. His song resembles that of the Robin, but is hoarser and harsher. The call-note of the Tanager is a cheer-

Yellow-billed Cuckoo. Cedar Waxwing.

JULY—A CHARACTER CONTRAST.

ful "Chip-chur," "Chip-chur." The nest is lined with cherry stems. The female is olive-green in color and has none of the resplendent markings of her mate. Why this difference?

13. **Swallows.** This family includes the Purple Martin, and the Cliff-, Barn-, Bank-, and Tree Swallows.

The Martins, from their color and size, cannot be compared with the other swallows. They nest chiefly about the gables of stores and other city buildings, and are generally welcomed wherever they take up their abode.

The Barn Swallow may be known by its chestnut forehead and under parts, its deeply forked tail, and its habit of nesting *inside* of barns and out-buildings. The Cliff Swallow is distinguished from the Barn Swallow by its white forehead, tail less deeply forked, whitish belly, and its habit of nesting on the *outside* of barns, under the eaves. The Tree Swallow nests in bird-boxes or in trees. Its under parts are pure white. The Bank Swallow nests at the end of a tunnel in a bank. Its coat lacks the lustre of the other species, and a gray band runs across the breast. One of the most noticeable characteristics of the Swallows is their sociability.

14. **Waxwings.** The Cedar Waxwing, or "Cherry Bird," in spite of his genteel appearance, is very hardy, and remains with us during the coldest winters. His chief food in winter consists of the red mountain-ash berries. The Waxwings remain in flocks

Young Waxwings.

until late in the spring. They pair off about the middle of May and during the breeding season are very secretive. They build their nests chiefly in the tops of the smaller shade trees in the city. The Waxwing has two prominent characteristics, extreme inquisitiveness, and anxiety regarding his personal appearance. He is the coxcomb of the feathered world. His note is a thin wheezy whistle.

15. **Shrikes.** There are two species of the Shrike or Butcher Bird in Canada, the Northern and the Loggerhead. The Northern is a winter visitor, but the Loggerhead arrives early in April and immediately proceeds to build its nest, a rough bundle of twigs, in some old isolated orchard. It is not common, however, in Southern Canada. The Shrike preys upon mice, beetles, etc., and, when hard pressed, will kill smaller birds. He generally impales his victim upon a thorn in order that he may be able to rend it with greater ease.

16. **Vireos.** Of the Vireos, or Weavers, we have in Canada two common species, the Warbling, and the Red-eyed. The Warbling Vireo is partial to the city and its liquid warbling song is one of the pleasantest strains of spring music. The Red-eyed Vireo is not found in the city, and in the country it keeps well to the tops of the tall trees. Its song is somewhat like that of the Robin, and may be heard continuously even in the most sultry hours of June and July. Wilson Flagg has called the Red-eye, the "Preacher," and interprets its notes thus,—"You see it—you know it—do you hear me?—do you believe it?"

17. **Warblers.** We have in Ontario a great many species of Warblers, most of them migrants. They pass their time principally in the tree-tops and are, on that account, difficult to observe. There are, however, at least three which are very common and easily observed, the Yellow Warbler, the Oven-Bird and the Redstart. The Yellow Warbler, or

Summer Yellow Bird, is very common both in city and country ; it must not be confused with the Goldfinch. The Oven-bird, so called because it builds an oven-shaped nest with entrance at the side, is found only in the thick moist woods. Its song is a loud crescendo **teacher, teacher, teacher, teacher, teacher.** It is sometimes known as the Golden-crowned Thrush. The Redstart is a dainty little bird with black and orange markings. It is found in thick damp woods where saplings are plentiful.

18. **Wagtails.** The American Pipit, the only member of this family which we have in Canada, is strictly a migrant.

19. **Wrens and Thrashers.** The House Wren is too common a bird to need any comment. Put up a bird box at the back of your house, making the entrance too small to admit a Sparrow, and sooner or later it is almost sure to have a cheerful little House Wren for a tenant.

The Catbird, Brown Thrasher, and Mocking Bird are the big brothers of the Wren. The Catbird is common to both city and country. In spite of his sober slate-colored dress and his disagreeable cat-like cry he is one of our best singers and when he takes up his position upon the top of a tall evergreen on a June evening his performance is well worth listening to. He is very inquisitive and when anything unusual is going on you are almost certain to find a bird with a slate-colored coat and black cap stealing through the underbrush to find out what is the matter.

The Brown Thrasher is a bird of the thickets and is fond of brush piles. His song is generally delivered from an elevated perch ; it resembles the Catbird's song closely, but is marked by regular pauses. To Thoreau, planting corn, the Thrasher from the tree near by kept repeating, "Drop it — drop it — cover it up — cover it up — pull it up — pull it up." The Mocking Bird is not found in Canada.

Chickadee. Nuthatch.

WINTER COMPANIONS.

20. **Creepers.** The Brown Creeper is a bird of the tree trunk. It is rare in summer but common in the migration seasons.

21. **Nuthatches and Titmice.** The White-breasted Nuthatch is one of our most common permanent residents. He finds his food on the trunk and branches of the trees and his life is one long pilgrimage up and down the bark. His note is a nasal *gnya*, *gnya*, *gnya*, one of the commonest sounds of the woods. Notice the change in tone in early spring.

The Black-capped Chickadee is a rare summer resident but is common in winter. He announces his presence by a cheerful twitter or a merry *tsic-a-dee-dee-dee*, and is one of the pleasantest companions in the woods. His nest is generally placed in a small stub and is usually lined with cow hair.

Young Chickadees.

" Chick-chickadeedee ! saucy note
Out of sound heart and merry throat,
As if it said, ' Good day, good sir !
Fine afternoon, old passenger !
Happy to meet you in these places,
Where January brings few faces.' "

22. **Kinglets and Gnatcatchers.** The Golden-crowned, and the Ruby-crowned Kinglets are common migrants, and their thin *tee*, *tee*, *tee*, as they move in flocks from tree to tree is one of the characteristic sounds of the woods in October. The Golden-crowned remains during the winter, and in the migration season may be readily distinguished from the Ruby-crowned by the yellow border to the crimson crown-patch.

23. **Thrushes and Bluebirds.** The common resident Thrushes are the Robin, the Wood Thrush, the Wilson's

Thrush and the Bluebird. The Robin and the Bluebird are among the first birds to return in the spring, arriving in southern Ontario about March 10th. The Bluebird may be readily distinguished from the Indigo Bird by its larger size, its red breast, and its nesting place in a hole of a tree or stub.

"Hark! 'tis the Bluebird's venturous strain
High on the old fringed elm at the gate—
Sweet-voiced, valiant on the swinging bough,
Alert, elate,
Dodging the fitful spits of snow,
New England's poet-laureate
Telling us spring has come again."


Young Wood Thrush.

The Wood Thrush is an attractive singer: it is generally found in damp woods. Compare the nest and eggs with those of the Robin. Notice the peculiar habit of putting a piece of paper among the leaves in the foundation of the nest.

The Wilson's Thrush, or Veery, is very common, but is very shy, and difficult to observe. Its song is a peculiar weird diminuendo, well suited to the moist thickets and to the dusky shades of evening in which it loves to sing.

"The Laverock sings a bonnie lay
Above the Scottish heather;
It sprinkles down from far away
Like light and air together:
He drops the golden notes to greet
His brooding mate, his dearie,—
I only know one song more sweet,—
The wood notes of the Veery."

Brown Thrasher. Wilson's Thrush or Veery.

MAY—AMONG THE THICKETS.

THE BIRDS OF WESTERN CANADA.

The birds of western Canada are, in general, much the same as those of the eastern provinces. In Manitoba and the North West, however, water fowl of all kinds are much more abundant than in the other provinces: and in the spring and fall especially, the lakes, rivers and marshes are the meeting place of multitudes of migrants. "It is scarcely credible the myriads of ducks that fill every pond and marsh in September and October, and no description could give an adequate picture of the astonishing sight." (Macoun.)

Of the land birds a few species found in western Canada are rarely met with in the eastern provinces. The most important of these western species are, the Missouri Skylark, the White-winged Blackbird, the Magpie, the Arkansas Flycatcher, the Marsh Owl, the Lapland Longspur, the Evening Grosbeak, and the Canada Jay or "Whiskey Jack." The Canada Jay is abundant also in northern Ontario and is a familiar object in the neighborhood of the lumber camps. He is next of kin to our common blue jay, but lacks the brighter colors of the more familiar southern species.

Pine Grosbeaks.

III. RELATION TO MAN

Not only do the birds do much to make life more cheerful and more enjoyable for us, but in another respect our debt to them is greater still, for if it were not for their service to us, life would be literally impossible. Their food consists, for the most part, of objectionable seeds, insects, and rodents, the rapid increase of which would render our existence altogether intolerable. If left to themselves there is little doubt that the birds would hold them effectually in check. But in the case of the birds, as of the mammals, the interference of man has, to a certain extent, disturbed the balance of nature, and we are forced to suffer the inevitable results.

The persecution and destruction of certain of the birds have been due partly to ignorance and prejudice concerning their food and habits, but in the case of others the decrease is due to thoughtless interference with their nesting habits, and to the activity of amateur gunners.

We have in reality in North America very few objectionable birds, and the knowledge of a few simple facts regarding certain families should be sufficient to regulate our relations towards them as a whole.

(1) **Hawks.** With the exception of two species, the Sharp-shinned and the Cooper's, our resident Hawks should be counted among the farmers' best friends. The two large Hawks, the Red-shouldered and the Red-tailed, although commonly called Hen Hawks, destroy little or no poultry, but, on the other hand, do away with large numbers of mice, reptiles, etc. The little Sparrow Hawk is equally beneficial. Of the Hawks that visit us in the spring or fall or in the winter, the only one which is not a positive blessing to the

farmer is the Goshawk. As a rule any Hawk which is seen in winter may be considered as undesirable and should be destroyed.

(2) **Owls.** The Owls, like the Hawks, have long been the victims of ignorant prejudice, and have suffered accordingly. The only doubtful member of the Owl family is the Great Horned Owl, who sometimes plays havoc with the poultry. The little Screech Owl, with whom most people are familiar, is one of the most useful birds that we have. It does not molest the farm-yard, and, on the other hand, it destroys large numbers of field-mice and insects.

(3) **Crows** and **Jays.** The Crow performs a certain service to the farmer in the destruction of a limited number of cut-worms, grubs, insects and mice ; but these good qualities are probably more than counterbalanced by its evil propensities. It destroys the sprouting corn in the spring, and later in the season proves an unwelcome visitor to the farm-yard and garden. Besides this, in the breeding season it carries off the eggs and young of the smaller birds to feed its own hungry brood. It should not be allowed to increase beyond a moderate limit.

The Blue Jay, in spite of his beautiful colorings, is not a profitable visitor in the garden. He destroys a certain amount of small fruit, and, like the Crow, is fond of the eggs and young of other birds. As, however, he destroys a considerable number of insects, and does no harm to the farmers' grain, he may be spared as long as he confines himself to the woods and does not molest the garden.

(4) **Blackbirds, Orioles, etc.** The Cow Blackbird, or Cowbird, has already been described (See page 57). This feathered parasite is responsible, more than anything else, for the decrease in the numbers of our smaller birds, and it should be destroyed, wherever met with. It has been esti-

mated that each female Cowbird represents a loss each season of from twenty to thirty other birds. The egg of the Cowbird is a dull white, generally thickly spotted with brown. It can be readily distinguished from the other eggs in a nest, and it should be taken out and destroyed, wherever found.

The Bronzed Grackle, or Crow Blackbird, the Rusty Blackbird, common in Manitoba, and the Red-winged Blackbird, are, all three, to be counted among the enemies of the farmer, on account of their destructiveness in the fields of grain in the summer. Besides this, the Bronzed Grackle destroys the eggs and young of other birds, and little can be said in his favor. The other members of the family, the Bobolink, the Meadowlark, and the Oriole are in the highest degree beneficial, and should be protected at all costs.

(5) **Woodpeckers.** The Red-headed Woodpecker, and the Flicker, do a certain amount of damage among the small fruits; and the Yellow-bellied Sapsucker, (a migrant in Ontario), has been accused of injuring growing trees by drilling holes in the bark. It is probable, however, that the damage done by these species has been over-estimated. The Woodpeckers in general are to be classed among the most beneficial birds that we have.

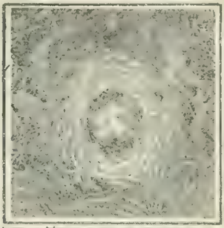
(6) **Sparrows, Finches, etc.** The House Sparrow, or English Sparrow, is the only member of this family that cannot be counted as a friend to the farmer. In favor of the English Sparrow it has been pointed out that it destroys considerable numbers of moths, beetles, worms, and insects. These good qualities are, however, more than counterbalanced by the damage it does. In the spring it plays havoc with the buds and the fresh bulbs and plants in the garden. Later in the season it destroys large quantities of grain. Besides this it is of a pugnacious disposition and has succeeded in driving out some of our most beneficial birds, notably the Bluebirds

and the Martins. Some birds whose economic value is doubtful, such as the Blue Jay and the Red-winged Blackbird, have either beauty of voice or plumage to recommend them; but the English Sparrow has neither. It increases very rapidly and its extermination is impossible; but it can be held in check by the use of the gun and by the destruction of the nests about the roofs of the houses. Wheat which has been soaked in a solution of arsenic may be used as a poison *in the winter time.*

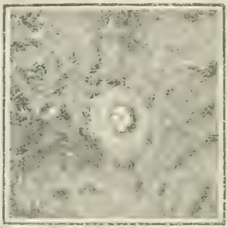
(7) **Wrens, Thrashers, etc.** The Catbird has suffered a good deal of persecution in the past, chiefly on account of its disagreeable mewing call-note. Besides being one of our finest singers, the Catbird is one of the most useful birds that visit the garden. Its food consists largely of beetles, caterpillars and grubs.

(8) **Thrushes.** The Robin has a fine taste for cherries and other small fruit, but there is no doubt that in the destruction of cut-worms and grubs of various kinds he more than pays his way. The Bluebird is becoming scarcer from year to year. The English Sparrow is partly responsible for this; but like the Tanagers and other birds of brilliant plumage, the Bluebird is a common mark for amateur gunners, and this, no doubt, has had something to do with its decrease. It should be protected in every possible way.

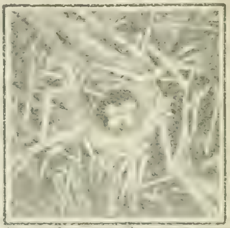
(9) The remaining birds are, without exception, valuable allies of the farmer, and some of them, such as the Cuckoos, Grosbeaks and Chickadees, render us especially valuable service in the destruction of caterpillars, moths and insects. The teacher cannot too strongly impress upon his pupils the economic value of the birds, and the necessity for their protection and preservation.



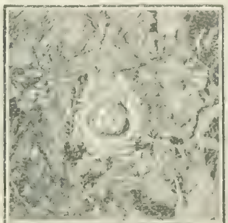
NEST OF MEADOWLARK IN A TUSSOCK OF GRASS. EGGS, WHITE, SPRINKLED BROWN.



NEST OF CHIPPING SPARROW IN THE [illegible] GREEN. EGGS, [illegible] SPOTTED BROWN.

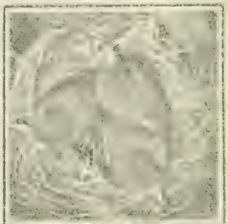


NEST OF RED-WINGED BLACKBIRD IN A MARSH. EGGS, PALE BLUE, MARKED WITH BROWN.

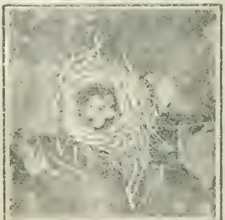


NEST OF WOOD THRUSH ON THE GROUND. EGGS, LIGHT BLUE

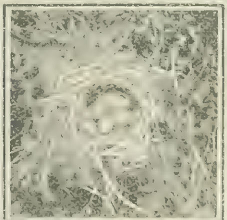
THREE YOUNG CROWS.



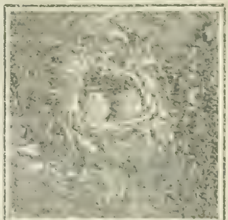
YOUNG CROWS IN THE NEST



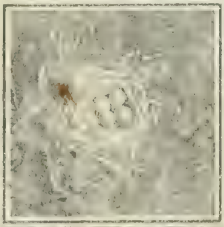
NEST OF WARBLING [illegible] IN WILD GRAPE VINE, EGGS, [illegible] BLUE, SPOTTED WITH BROWN.



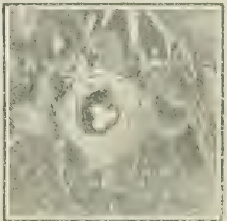
NEST OF CUCKOO, IN A HAWTHORN, WITH YOUNG CUCKOO.



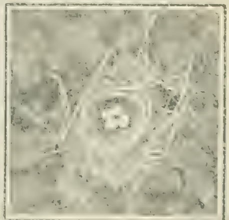
YOUNG OVENBIRDS [illegible] THE DOOR OF "THEIR OVEN."



NEST OF KILLDEER, IN A STRAWBERRY PATCH, EGGS, CLAY COLOR, BLOTCHED WITH BROWN.



NEST OF ROBIN, IN AN APPLE TREE. EGGS, CREAM COLOR, SPOTTED WITH BROWN.



NEST OF ROSE-BREASTED GROSBEAK. EGGS, GREENISH BLUE, SPOTTED WITH BROWN.

IV. METHOD OF STUDY

"In summer when the shawes be shene,
And leaves be large and long,
It is full merry in fair forest
To hear the fowles' song.
The Wood-wele sang, and wolde not cease,
Sitting upon the spray;
So loud, it wakened Robin Hood
In the greenwood where he lay."

The chief difficulty in the study of birds lies, not so much in the lack of opportunities for observation, as in the width of the field to be covered. The nature-student finds himself at the outset bewildered by the number and variety of forms of bird life, and he is oftentimes discouraged by his inability to distinguish between the different species. This difficulty is moreover increased by the fact that a bird which the student has learned to recognize in one form, sometimes, under different conditions, appears like a totally different species. In the Bobolink and the Scarlet Tanager, for example, there is a wide variety of plumage, and the colors vary according to the age, sex, or season of the year. Besides this, if we attempt to identify a bird by its call-note or its song, we find that each bird has its own vocabulary. The Warbling Vireo, for example, has three distinct notes, and the Marsh Blackbird has an extensive vocabulary of eight or nine different vocables; so that, in the recognition of an individual species, unless the student is familiar with the whole range of the bird's expression, he will often find himself puzzled by an unfamiliar call-note or song.

In addition to these difficulties there is a third which is certain to be noticed by the beginner at least. Nature reveals to us only the forms for which we bring ears and eyes, and it requires a certain amount of training to the

sights and sounds of nature to enable us to become conscious of a great deal of the life that is about us. For example, in our towns and cities how few people there are, even among those who ordinarily are susceptible to the beautiful in the world about them, who are even aware of the presence of the Oriole in the over-arching boughs, or are conscious of the beauty of his architecture and his song. And even among those who have become fairly familiar with the world of nature, how many are there who can remember the time when even the most common sights and sounds in nature would attract their attention? The call of the Highhole, the lisping of the Chickadee, the restless flitting of the Warblers in the tree-tops, the poise of the Hawk, and even the harsh scream of the Jay—were in themselves revelations of a world hitherto unseen and unknown.

The nature student will find it impossible to overcome these difficulties entirely; but they may at least be minimized by attention to certain details in the method of observation.

It need scarcely be pointed out, in the first place, that the study of birds, as well as the study of mammals, demands the utmost patience on the part of the observer, and that cautious movement and absolute silence are necessary to successful observation. The so called nature-student who rambles through the woods, gun in hand, with two or three boon companions, is likely to learn but little of bird and animal life. The wisest course for the beginner to follow is to select a favorable point for observation and then to sit down quietly and wait for the birds to show themselves. "You need only to sit still long enough in some attractive spot in the woods," says Thoreau, "that all its inhabitants may exhibit themselves to you by turns."

The student, however, must be careful not to confine his observations too strictly to any one locality, for according as he takes up his position in the meadow, the orchard, the

river-side, the thickets, or the deep still woods, he will find different kinds of birds to observe. As a general thing the beginner will find very few birds in the thick woods. Birds prefer the sunshine ; and a half-clearing, overgrown with thickets and interspersed with old stumps, raspberry vines, etc., is generally a favorite spot.

In the study of birds much, of course, depends upon favorable opportunities for observation. The student himself can, however, do much to facilitate the identification of the different species. He must, in the first place, make himself familiar with the most important facts concerning their haunts and their habits, and learn to make use of these facts in forming his conclusions. We will suppose, for example, that about the beginning of June he notices, in the evergreens, a sparrow which he wishes to identify. From his knowledge of the winter birds, he knows that it cannot be a Tree Sparrow ; the White-crowned and the White-throated are also excluded as migrants ; the Vesper Sparrow is a ground bird and belongs to the fields ; the Field Sparrow is found only among the copses at the edge of the woods. The only two common Sparrows left are the Song Sparrow and the Chipping Sparrow, and these may be readily distinguished by their markings, their songs, or their nests.

The identification of a bird is, of course, only preliminary to the complete study of its habits. The student must make himself familiar with the dates of migration, the nesting habits, food, song, flight, variation in plumage, etc., of the different species; and the work of the advanced student will, of course, include the study of protective coloration, and adaptation to food and environment. It is important that the observations made regarding the habits of the birds should be accurate. The student should carry with him a note-book, and the various points which come under his notice should be written down without delay. The beginner should aim to

become closely acquainted with the habits of one or two species each year. A definite knowledge of one or two typical birds is much more valuable than a mass of general facts regarding a great many.

The nesting season is, of course, the best time to make observations. The birds are then less shy and more easily approached. Besides this, it is in the process of mating, selecting the site for the nest, constructing it, brooding, and caring for the young, that we see the characteristic instincts and habits of the species.

The utmost care, however, must be taken not to disturb the nesting operations. The eggs must not on any account be handled, and the mother bird must not be annoyed by repeated visits to the nest. Above all, children must not be permitted to interfere in any way with the nest and eggs.

Unless extreme caution is observed the mother bird will desert the nest and the opportunity for further observations will be lost.

The difficulty of making minute observations of the appearance and actions of a bird may be overcome to a large extent by the use of a field-glass, or a good pair of opera glasses. The student who wishes to make an accurate study of the various species must, in addition, provide himself with some standard work on birds. Chapman's *Birds of Eastern North America* is one of the best published.

Except for the destruction of objectionable species such as the Cowbird, the use of the gun in connection with bird study should be discouraged. There may be special cases where the naturalist may be excused for collecting a rare specimen for identification, in the migration season. But, in general, the bird-student who uses a gun simply defeats his own ends. It is not important that the beginner should have a detailed knowledge of the minute markings of a certain species; what is of importance in bird study is that he should gain some

definite information about the instincts and habits of the living bird. The use of the gun puts an end at once to all opportunity for observation and study. In general it is only the beginner who is tempted to have resort to shooting as a means of securing a bird for identification. The advanced student knows from experience that a little patience will accomplish much more than powder and shot; and besides this, with an increasing knowledge of the birds there is sure to come an increasing sympathy with them, which prevents the true naturalist from wantonly taking life.

The same remarks apply to the habit, common among boys, of "bird-nesting" and egg collecting. A single boy, infected with the craze for collecting eggs, can do more harm in a community than all the other bird enemies combined. In towns and cities sometimes the mania for bird-nesting becomes so strong among the school boys that thousands of eggs are destroyed in a single season. Besides the fact that the destruction of these eggs represents an economic loss to the community, the custom of egg collecting, it need not be pointed out, is both useless and cruel. The teacher can of course do more than anyone else to minimize the evil, and in his talks to his classes, he should not fail to emphasize repeatedly the economic value of the birds, and should endeavor to interest his pupils in the nesting habits of the birds themselves and lead them to take a pride in protecting rather than in destroying the nests.

Every pupil should keep a bird note-book for himself, in which to record the dates of migration and of nesting, the location and description of the nests, the length of the period of brooding, the care of the young, etc.; and a permanent school note-book should be kept in which the records of the bird-life of the locality may be recorded. An active interest in bird-life, on the part of the pupils, is the best guarantee for the protection of the birds themselves.

Butcher Bird.

Kingbird.

WHERE MIGHT IS RIGHT.

V. STUDY OF THE KINGBIRD

Length 8½ inches; upper parts, grayish-black; tip of the tail and under parts, white; wings, whitish on the edges; bill and feet, black; a flame-colored crown-patch: in young birds the crown-patch is wanting.

It is not an uncommon sight in May or June to see, outlined against the sky, a crow pursued by two black specks, evidently two smaller birds, which are making furious attacks upon the retreating intruder, sometimes dashing at his head and eyes, sometimes crossing his path and hindering his flight, and sometimes even alighting on his back and pecking furiously at the feathers of his neck and head.

To the student who is familiar with nature, a scene such as this is no surprise. It is simply a couple of Kingbirds driving off an intruding crow who has dared to venture his unlucky head within the limits of their domain.

For one season of the year at least, the Kingbird is a fighter, and on account of his fighting propensities he is sometimes known as the Tyrant Flycatcher. In the spring, having chosen his nesting location, he vigilantly guards the approaches, and woe betide the unfortunate hawk or crow or jay who ventures too near and falls under the owner's displeasure!

But though the Kingbird is a fighter, the name Tyrant is somewhat of a libel. Except in defence of his own nesting ground he never wantonly attacks other birds, and in the summer season, after the nesting and brooding is over, he gives up his local attachments and is one of the most peaceable birds that we have.

It is mainly to his obtrusiveness in the nesting season that he owes his name of Kingbird, and the title is rendered all

the more appropriate from the fact that nature has set off the modest colors of his dress with a ruby crown.

Among the farmers he goes by the name of "Bee-bird" on account of his reputed fondness for bees. Indeed I have heard it said that when the ruby feathers of the Kingbird's crown are erect, they resemble a flame-colored flower and are a means of attracting the bees. A prejudice such as this is hard to eradicate, and it is difficult to convince the average farmer that the Kingbird does not eat bees at all, or, at most, only helps himself to a few useless drones, who generally fly higher than the worker bees and sometimes come within range of the Kingbird's sharp eyes.

The Kingbirds do not care for vegetable food, although, when hard pressed, they will sometimes help themselves to a few berries. Their food consists, for the most part, of beetles, dragon-flies, moths, and insects of all kinds, and I have, on more than one occasion, seen them carry off the Cicada or Dog-day Locust.

One summer afternoon a few years ago, when passing along a country road, I stopped to observe a colony of Sand-Hornets or Digger-Wasps who had established themselves by the roadside. Each wasp had, of course, bored a tunnel of her own, seven or eight inches deep into the ground, and was busily engaged in stocking it with crickets and grass-hoppers for food for the growing larva. Sitting on the fence overlooking the wasp colony were two Kingbirds who were watching very intently the operations of the wasps on the ground below. Every few minutes either one or the other of them would dart suddenly from the fence towards the ground, make a circle through the air, and return to the fence again to resume the absorbing scrutiny of the wasp colony. What could it all mean? I stood watching for a long time until at last, during one of the Kingbird's sudden excursions, I got a

glimpse of something green, and then it all dawned on me. The Kingbirds were playing the part of highwaymen and were making an easy living out of the green grasshoppers which were being laboriously gathered in by the hard-working hornets. It is not man alone that, when opportunity presents itself, is given to sharp practice.

The Kingbirds do not arrive in Canada until about May 8th, when insect fare begins to be plentiful. They immediately choose out their nesting location, generally an isolated tree in the orchard or by the roadside; but it is not until the latter part of June that they commence to think

Kingbird's Nest.

seriously of housekeeping. The nest is generally placed near the end of a limb, some twenty feet from the ground. It is a round structure, compactly made, and is composed of weed-stalks, grass, and moss, with a lining of fine grass and root-

lets as well as a considerable quantity of sheep's wool. The eggs, three to five in number, are very pretty. In color they are creamy-white, spotted with chocolate-brown. About the middle of July the young are ready to leave the nest, and a noisy household they make until they are able to shift for themselves.

During the hot midsummer days when most of the other birds have taken refuge from the heat, the Kingbird is one of the familiar features of the country roadside. In the pasture field he generally takes up his position on a swaying mullein-stalk, whence his sharp eye keeps a keen look-out upon the territory round about. He is fond of the water too, perhaps because of the insects that it attracts; at all events he is not averse to taking a sudden plunge, but, on the other hand, seems rather to enjoy the experience.

In spite of his obtrusiveness during the nesting season he is not of an unsociable disposition, and will allow you to approach him to within a short distance.

It is a well known fact that the vocal organs of birds are constructed very differently from those of human beings; for the bird's song does not come from the throat, strictly speaking, but from the complicated air-chest, called the syrinx, at the bottom of the windpipe. According to the nature of the syrinx, our perching birds are divided into two sub-orders, the Oscines or true song-birds, and the Clamatores or songless birds. To the latter class the Flycatchers belong: all of our other perching birds belong to the sub-order Oscines. In the true song-birds "the syrinx possesses four or five pairs of intrinsic muscles, while in the Clamatores it has less than four pairs of muscles and is not so highly developed."

The Kingbird is, accordingly, not a singer, but though his voice is not so finely modulated as that of the singing birds, he nevertheless puts it to constant use, and the loud *kesee*,

kezee, which, under the influence of excitement, sharpens into a series of inarticulate shrieks, is familiar to almost every one who has occasion to pass along a country road. On a hot midsummer day it is not an uncommon thing to see two Kingbirds chasing each other round and round and rising higher and higher in the air, giving utterance all the while to a series of excited twitterings and cries.

In September, as soon as insect life becomes less abundant, the Kingbird leaves for the south. It winters in Central and South America where no doubt it finds suitable insect food.

Among the Water Lilies. The Feeding Ground of the Kingbird.

THE STUDY OF REPTILES

The term Reptile is usually associated with snakes only, but it includes lizards, crocodiles and turtles, as well as snakes. In fact, the lizard is the typical reptile, while the snake is a degenerate type, as the absence of limbs shows. Lizards, however, are found but rarely in Canada, and only in the western part. The reptiles of Canada, then, are practically limited to snakes and turtles, the crocodiles being entirely unrepresented.

Reptiles are air-breathing animals provided with lungs. Their bodies are covered with scales, and this characteristic distinguishes them from the Salamanders, which belong to the class Amphibia. Unlikely as it may appear, they are near relatives of the birds.

This relation of birds and reptiles has been established by the comparison of existing species and by the study of species long since extinct, which show a gradual modification of the fore limbs into organs of flight. These extinct species, which have been found in large numbers in certain rock formations, must have been terrible creatures in size and appearance. They so dominated one period of the earth's past history that it is spoken of as the Reptilian age. Dana says that the species known as Dinosaur, probably stood over twenty feet high. Another, named Atlantosaur, had a body probably sixty feet long. Some of the Ichthyosaurs were thirty feet long and the Plesiosaurs about the same length. Certain flying reptiles had a spread of wing of ten feet. In fact, one can scarcely credit the accounts given until the actual remains are seen in our museums.

I. OPHIDIA, OR SNAKES

Our common Snakes are the Garter Snake, the Water Snake, the Grass Snake, the Milk Snake, the Little Brown Snake and the Black Snake. These are non-poisonous species. The poisonous species are the Rattlesnake and the Copperhead, both restricted to unfrequented rocky tracts. The latter is rare north of 45° N. Lat.

The poison is contained in a sac above the jaw, and is forced through a pair of hollow fangs, by pressure, when the snake bites on any object. The protrusible, forked tongue, usually regarded as the "sting," is quite harmless.

All snakes have an extremely wide gape, because the lower jaw can be disjointed from the upper, to which it is united by an elastic ligament. They swallow their food (frogs, insects, small birds, fish) whole. The eye has a "glittering stare," due to the absence of lids.

Most of the snakes lay eggs, but some venomous species and a few fresh water forms bring forth their young alive.

The common Garter Snake *(Eutania sirtalis)* occurs everywhere in North America, except in California. It is olivaceous in color above, and greenish on the sides and underneath. A narrow, obscure stripe runs along the back, and rather broad but inconspicuous stripes adorn the sides. There are three series of small dark spots on each side—about seventy between the head and the vent.

A description of common Snakes, as given by Jordan, is appended for reference :—

WATER SNAKE. Brownish, back and sides each with a series of large, square, dark blotches, alternating with each other; very abundant about streams, feeding on fish and frogs. Length 30 to 50 inches.

GRASS SNAKE. Head, elongate; neck, slender; eyes, very large; uniform deep green; yellowish below. Length 20 inches.

MILK SNAKE. Grayish, with three series of brown, rounded blotches bordered with black; square, black blotches beneath. Length 30 to 50 inches.

BROWN SNAKE. Head, elongated on a small neck; eyes, large; reddish gray, salmon-red beneath. Length 10 inches.

BLACK SNAKE. Lustrous pitch black; greenish below; chin and throat white. Length 50 to 60 inches.

II. CHELONIA, OR TURTLES

Turtle.

The Mud Turtles are more attractive than snakes for nature study. Two or three small turtles may easily be obtained for the aquarium, in which they may be carefully observed.

Observe their movements in water and on land. Describe each. How do they breathe in water? They have no gills. Feed them with slugs, small fish, meat, or vegetables. Have they any teeth? Old and young are alike in this respect. How do they protect themselves when attacked?

Examine the turtle's scaly covering carefully. Head, tail, and limbs project from a more or less perfect "box," formed by the union of the scales into an upper shield (carapace), and a lower one (plastron). Count the number of scales in each, and note how they are colored. How many toes are on the

front feet and on the hind feet? Compare with the frog or the snake.

Avoid coming within reach of the jaws, as they are very strong, especially in the full-grown turtle.

The turtles lay their eggs in sandy banks near the water, excavating a hole with the hind feet and depositing therein twenty or thirty round, white, leathery-shelled eggs, about as large as a pigeon's. If there is a sod surface, the turtle will cover the nest so well as to leave no trace of its work. I once saw a turtle preparing its nest, but on returning later could find no sign of an excavation, even after careful searching. In the fall, however, the empty shells were found on the very spot where the turtle had been seen.

The sun will cause the eggs to hatch in about three months, and, after so long an incubation, the young are well developed. They immediately take to the water and although they grow very slowly, they attain to large proportions at an advanced age.

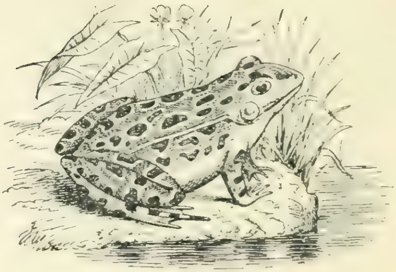
The turtles found in Canada are:—the Snapping Turtle, the Pond Turtle, and the Box Turtle, and, rarely, the Spotted and the Musk Turtles. A description of the first three, partly as given by Jordan, is appended.

SNAPPING TURTLE. Shell high in front, low behind; jaws strongly hooked; tail long, strong, with a crest of horny tubercles; plastron small, cross-shaped; claws, five in front, four behind; color, dusky-brown, head with dark spots; length of adult, two feet or more; common about water, everywhere.

POND TURTLE. Carapace ovate, broadest behind, the margin having a tendency to flare outward; plastron covering the whole under surface; toes, broadly webbed; color, greenish-black, marginal plates marked with bright red; plastron, yellow, often blotched with brown: length, about a foot; very common.

BOX TURTLE. General shape as in preceding, but provided with hinged plates, which enable it to completely close its shell, and thus actually form a box; color, variable, chiefly blackish and yellowish; inhabits dry woods and is active only at night.

THE STUDY OF AMPHIBIA



Leopard Frog.

The Amphibia include the Frogs, Toads, Tree Toads and Salamanders. The Mud Puppy may also be included. They are all animals with slimy or, at least, scaleless bodies, with four or five-toed limbs, and they pass through different stages in their life history (metamorphosis) before reaching the adult form.

It is said that Barnum's manager once came to him with the story of a wonderful animal, which at one time was a fish, at another a biped, then a swimming quadruped with a long tail, and again a tailless land animal with four legs. "Secure it at any price," cried Barnum, little suspecting that it was none other than our common toad. Perhaps the description is equally strange to many ears!

Send the boys on an egg-hunting expedition, not to the barns or hedges, but to some shallow pond, about the middle

or end of April (depending on the season). There they will find strings of small black eggs, or masses of brown ones. The former are toads' eggs, the latter, frogs' eggs. Several dozen of these may be kept in a shallow pan in water. Bring water, including a little mud and a few small stones, from the pond every day or two, to make up for the evaporation and to supply the tadpoles with food.

I shall not spoil the pleasure of the earnest student by giving the life history of the toad or of the frog, as it may be observed in the course of six weeks or more, but shall give a few precautionary directions.

Examine the mouth carefully and observe it day by day as its gape extends farther back.

Look for the external gills as soon as the tadpoles begin to swim. There are three pairs of gills, but two of these pairs are much larger than the third pair.

A fold of skin grows over these gills, and eventually covers them completely, but a small opening on the left side remains as long as the gills persist. Later the gills disappear entirely, lungs being formed in the body cavity.

When the hind legs begin to bud out, look for the fore legs under the above-mentioned covering of the gills.

At first the tadpole lives altogether under water. Note carefully when it begins to come to the surface for air. Examine the gills then.

Examine the size and structure of the tail. Some people think that it drops off. Does it? When does the young tadpole leave the water and live on the land? Describe the mode of locomotion in water and on land. How is the animal adapted to its different stages in life?

The tongue of a frog or of a toad is attached by its front end only, to the floor of the mouth. It ends behind in two points, and is quite sticky. Place a toad in a box covered

with netting, put in some flies, caterpillars, etc., and observe how it catches them.

It has been estimated that a "good sized toad will destroy nearly ten thousand insects and worms in a single season." It is evident that the toad is a beneficial animal, and is worthy of protection. It cannot harm any one, notwithstanding popular belief to the contrary.

Besides thoughtless boys, who sometimes kill the toad, it has other enemies, especially snakes and large birds.

A toad sheds its skin occasionally, pulling it off and leisurely swallowing it. This shedding of the skin or the shell is common among the lower animals. Snakes slough their skins several times during the year. Crayfish cast their shells annually. Spiders and insects 'moult' their skins. The moulting of birds is a similar phenomenon.

When cold weather comes on, the toad becomes drowsy, digs a hole in moist ground with its hind feet, and gradually works itself into the ground to the depth of a few inches. Here it remains in a torpid state during the winter. In the spring it comes forth with a good appetite for the insects upon which it lives.

Look for buried toads in the garden late in the fall of the year. The burying process may be observed if a toad is kept in a box half-filled with earth.

Frogs bury themselves in the mud at the bottom of ponds, instead of in the moist earth. Both frogs and toads, in common with reptiles, crayfish, snails and all other animals of low organization, can withstand low temperatures successfully. Toads are necessariiy surrounded by frozen earth for the greater part of the winter, and the ponds, under which frogs are buried, often freeze solid. I have seen a crayfish, thawed out of ice and apparently dead, revive in a short time. The Mourning Cloak, and related species of butterflies, also

hibernate in this country by hanging in quite unprotected places all winter, reviving in early spring before the snow has disappeared.

The Tree Toads are interesting because they have disk-like toes, which help them to cling to smooth surfaces such as leaves, window-panes and bark. Our most familiar Tree Toad, *Hyla versicolor*, is a small frog, about two inches long. It is variable in color, either pale green, brown, or

Tree Toad. *Hyla Versicolor.*

grayish above, and whitish-yellow below. The upper surface is marked with irregular, lichen-colored blotches. The color is largely determined by the color of the surface on which it rests, but a change from one color to another requires a long time.

Its call, "a clear, loud, trilled rattle," is most commonly heard among the trees on damp or rainy days, or in the evening. When making this call its throat is much inflated.

Tree Toad. *Hyla Pickeringii.*

Hyla Pickeringii is yellowish-brown, or fawn-color, with a cross-shaped marking on its back. It is about one inch

long. After having deposited its eggs in the swamps, it lives in the woods, on the ground in summer, in the trees in autumn.

However repulsive the common frogs and toads may be, there is nothing about the tree toad to repel the most fastidious. Its structure and coloring are so delicate, its manner so gentle, that one is attracted rather than repelled by it.

The Salamanders are tailed amphibians. Two species, the Brown and the Spotted, are common in parts of Canada, more especially among damp rocks in the mountainous districts. The spotted species attains a length of six inches, the tail being about one-third of the whole length. It is black, with two rows of bright yellow spots on each side. Its nose is rounded and blunt.

The Salamander.

The brown, or red-backed, salamander is about three inches long and of a dull brown or reddish color.

One species, *Amblystoma tigrinum*, common on the western plains, reaches a very large size before losing its gills. The color varies from uniform brown to yellow, but it is usually spotted. The adult is eight inches long.

The Newt, or Red Eft, is found under stones near pools. The back is olive or red; the under surface, yellow, or orange; the sides, spotted.

The life history of the tree toads and salamanders is practically the same as that of the frog or the common toad. All are beneficial animals, deserving our protection.

The Mud Puppy, *Menobranch*, attains to large and repulsive dimensions, (a foot long). It is dark-grayish or slaty in color with faint spots. Three bright red gill-tufts adorn the sides of its neck. The four short legs are small compared with the body. It is found in streams and shallow lake margins. Compare this animal with the frog or the toad in the tadpole stage.

Mud Puppy.

Descriptions of the common species of frogs and of our only species of toad are given for reference.

Bull Frog. Very large (5 in. to 8 in.), green with small faint dark spots above; head, usually bright pale green; legs, blotched; toes, broadly webbed.

Leopard Frog. Length 2¾ in., bright green with irregular black blotches with whitish edges, mostly in two irregular rows on the back; two yellowish lines along the back; legs, barred above; common.

Green Frog. Length 3 in., green or brownish with irregular small black spots; arms and legs blotched; yellowish or white below.

Wood Frog. Length 1½ in., pale reddish-brown; arms and legs, barred above; common in damp woods.

Swamp Frog. Length 2¼ in., light brown, with two rows of large, oblong, square blotches of dark brown on the back; one dark line from nostril to eye.

American Toad. Jaws toothless and skin of adult very warty, which are the main distinctions from frogs.

Note.—The Tree Toads are Frogs though commonly called Toads.

THE STUDY OF FISH

An exhibition of fish in their natural habitat always attracts a crowd of interested observers, boys, girls, men and women. At a recent exhibition of this kind the guards were kept busy, often without success, trying to keep the crowd moving. Subdued exclamations, eager remarks, and shouts of laughter were heard on all sides.

We expect children to get their information from books, or, a trifle better, from dead specimens. But all experience proves, that, with young or old, it is the living specimen which fixes and holds the attention.

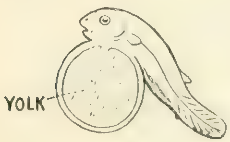
Too often, the aim of the observer is to convert the interesting living specimen into a mass of dead matter for the mere satisfaction of exhibiting his skill of markmanship. We should rather "name all the birds without a gun, love the wood-rose and leave it on its stalk,"—that is to say, we should study the living specimen in its natural habitat. This is beautifully expressed by Emerson.

> "I thought the sparrow's note from heaven,
> Singing at dawn on the alder bough;
> I brought him home in his nest, at even,
> He sings the song but it pleases not now;
> For I did not bring home the river and sky;
> He sang to my ear—they sang to my eye.
> The delicate shells lay on the shore;
> The bubbles of the latest wave
> Fresh pearls to their enamel gave,
> And the bellowing of the savage sea
> Greeted their safe escape to me.

I wiped away the weeds and foam—
I fetch'd my sea-born treasures home ;
But the poor, unsightly, noisome things
Had left their beauty on the shore,
With the sun, and the sand, and the wild uproar."

In 1901 thirty-five million pounds of salmon were canned in this country. The total value of the fisheries of Canada is nearly forty million dollars per annum. Surely Canadians should take an interest in the study of fish and their habits, in order that this industry may be maintained, if not materially increased.

The centre of interest in this class is the adult rather than the young fish, though there are some interesting phases in its development. The eggs are deposited in different places, according to the species of fish. Salmon, Suckers, Pike, Carp and Mullet ascend creeks and rivers ; Bass, Whitefish, Lake Trout, Perch and Pickerel deposit in shore waters ; the Stickleback builds a nest.



Young Catfish. *Wright.*

Young Salmon. *Parker and Haswell.*

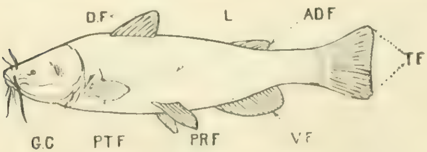
The young fry, after hatching, have still a portion of the egg-yolk attached to them, which supplies them with food for a time. A Catfish requires three months to attain the adult form, but the time required by different species varies according to circumstances. Thus the Whitefish spawns in November, and the eggs require about one hundred days to hatch out. The eggs of the Sea Salmon require a longer time than this to hatch, and the period of development extends over several years.

For ordinary study we are limited to the smaller fish of our creeks and rivers. The Shiner, Chub, Minnow, Sunfish, Bass, Perch and small Brook Trout may be obtained in any part of the country; at least one or more of each species may be secured for examination. From the lakes and the ocean, the young of the larger fish may be procured for the same purpose.

In any of these fish, study the movements, up, down, and forward. Observe the motion of each fin and tell how it assists the movement of the whole fish. Observe the motion of the gill-covers and jaws. Why are they continually moving? Count the number of gills and the openings between them.

As the water passes over the gills, the blood passing through the gill-filaments absorbs the oxygen dissolved in the water, and is purified. The gills are attached to bony arches, with openings between them. On the inner sides of the arches, projections (gill-rakers) may be seen. These vary in number and length in different species of fish. They are few, short and blunt in the Perch; long, narrow and numerous in the Herring. They act as strainers to prevent solid matter passing over the gills.

Examine the structure of the body, its protective covering of scales, and their arrangement. What parts of the fish have no scales? Note the arrangement of the fins. There are two groups of these, *i.e.*, those in a perpendicular plane, of which the tail fin is one, and those in a horizontal plane, two pair, pelvic and pectoral. It is important to note the fin-rays and to count them. Examine the gill cover Note the openings on the nose. They do not open into the mouth. Why not? Have the eyes any lids? Fish usually



A.D.F.—Adipose fin. D.F.—Dorsal fin. G.C.—Gill cover. L.—Lateral line. PT.F.—Pectoral fin. PR.F.—Pelvic fin. V.F.—Ventral fin. T.F.—Tail fin.

have small teeth but they are not in sockets as ours are. They serve to hold their prey.

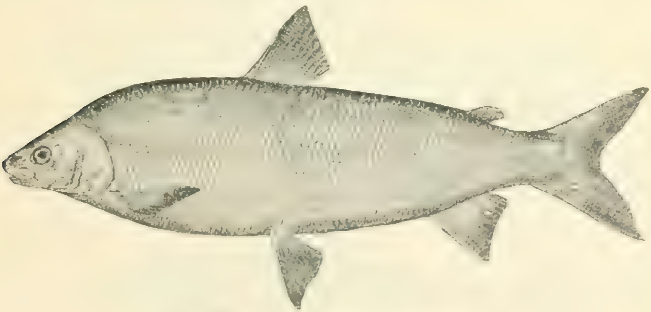
The line along the side of the body, present in nearly all fish, is the seat of sensory nerve endings. It is called the "lateral line."

In winter fish live in deep water. If, however, their natural habitat is a shallow stream, which may freeze nearly solid, they bury themselves in the leaves and sediment at the bottom, and thus survive the winter.

Fish and Amphibia are cold-blooded animals—that is, their temperature is below the average temperature of the element in which they live. Hence they can withstand cold successfully.

TYPES OF FISH

The White Fish is a type of our most important family of fresh-water fish (Salmonidæ).

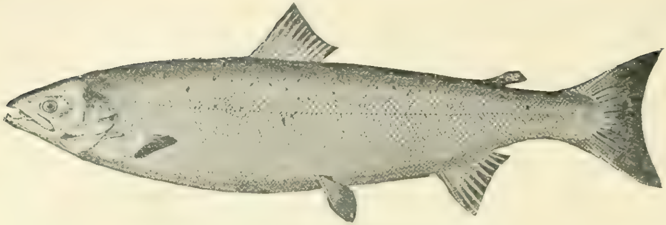


The White Fish—Length, 30 inches.

Note the small head and deep body. The scales are white but not silvery.

The Lake Herring (Cisco), Salmon, Salmon Trout, Brook Trout, Grayling, and the Tullibee of Manitoba are members of this important family.

The Salmon is the most valuable fish of the sea, except the Cod.



The Atlantic Salmon—Length 3 to 4 feet.

The Lake Herring, on account of its abundance and cheapness, is an important fish throughout the whole lake region.

The Lake Herring or Cisco—Length, 15 inches.

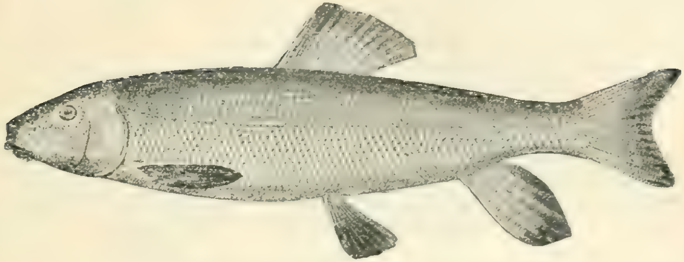
The Sea Herring, (Clupea harengus), belongs to the Clupeidæ. There is no lateral line, and no adipose fin. The gill-rakers are long and slender.

The Alewife and Shad are related species.

The Sea Herring—Length, 12 inches.

The Sucker is a widely known fish because of its habit of ascending streams and rivers in spring. The jaws are toothless, lips thick and fleshy.

The Mullet and Chub are members of the same family. (Catostomidæ.)



The Common Sucker—Length, 18 inches.

The Catfish is peculiar in lacking the ordinary scale covering, the skin being soft and slimy. There are eight barbels around the mouth. Each fin has a hard ray, which makes the fish formidable to handle.

The Catfish Length, 9 to 12 inches

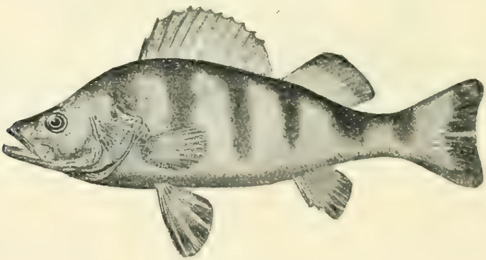
The Maskinonge is famous for its large size and gamey qualities. It is especially common in the small lakes of Ontario, but is found also in the great lakes and in the North-West.

The Maskinonge Length, 4 feet.

The related species, **Pike,** is grayish in color with many round, whitish spots.

The Pike—Length, 2 to 4 feet.

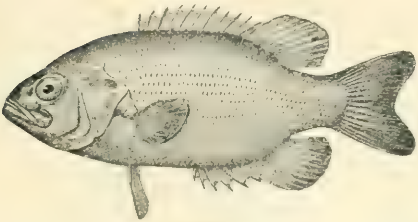
The Percidæ are represented by the **Yellow Perch** and the **Pickerel.** The former is a small fish of little value for food, but the latter is a valuable food fish.



The Perch.

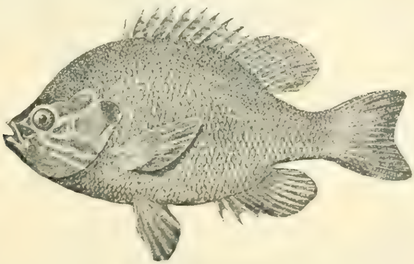
Note that the dorsal fin is divided into two parts, but there is no adipose fin. Adipose means fleshy, or lacking spines. The dorsal fins have characteristic dark markings in the Pickerel.

Bass are noted for their gamey qualities rather than for their size, but their flesh is of excellent quality. There are several species, as the Rock Bass, White Bass, Black Bass, Calico Bass, Sun-fish. The body is short, and flat on the sides ; scales, large ; dorsal fin, continuous.



Rock Bass.

The Sun-fish is distinguished from the Bass by a bright red spot on each gill-cover.



The Blue Sun-fish.

The Mackerel is a famous marine fish which runs in large schools. It is characterized by its dark blue color, and has about thirty-five wavy stripes across its back.

The Mackerel Length, 2 feet.

The Tunny, or Horse-Mackerel, one of the largest of fish, sometimes weighing 1500 pounds, is a related species.

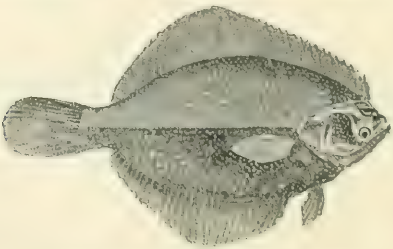
The Cod is probably the most famous food-fish in the world, and the Banks of Newfoundland, where it feeds in such great numbers, have been the fishing-grounds of nations for years, without in any way lessening the annual catch.

The Cod – Length, 3 feet or more.

The Haddock, length 30 inches, is a well-known related species.

The Halibut grows to a length of six feet or more and to a weight of 400 pounds. It is found chiefly on sandy sea-bottoms. The members of this family are peculiar in having the head twisted so that both eyes are on the colored side.

The Flounder and the **Sole** are related species.

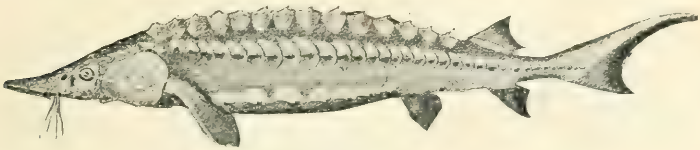


The Flounder—Length, 12 to 18 inches.

The Sturgeon, Gar-Pike and **Bowfin** are the only existing

species of a once numerous group of fish, the bony-scaled fish called Ganoids.

The mouth of the Lake Sturgeon is on the under surface, and this adapts it to bottom feeding. It may reach a length of six feet, and a weight of 100 pounds or more. A marine species, Acipenser Sturio, reaches a length of twelve feet.



The Lake Sturgeon—Length, 6 feet.

The Gar-Pike resembles the Pike in the position of its fins, but its prominent jaws and teeth easily distinguish it. It is useless for food.

The Gar-Pike—Length, 5 feet.

THE STUDY OF MOLLUSKS

All the animals hitherto mentioned, Fish, Frogs, Reptiles, Birds, and Mammals, have an internal skeleton, part of which forms a backbone, made up of a series of small bones called vertebræ. Hence the members of this whole group or branch of the animal kingdom are known as Vertebrates. Those animals which we are now to study have no backbone —in fact, have practically no bones at all, and are therefore called Invertebrates.

In many cases they are provided with a hard covering, as in the Clam, Crayfish, and Grasshopper. This is called the exoskeleton, or outer skeleton, while the bones of the Vertebrates are called the endoskeleton, or inner skeleton.

The scales of fish and of reptiles, the feathers of birds and the covering of certain mammals are exoskeletons, which these animals have in addition to their endoskeletons.

The Mollusks include Snails, Slugs, Clams, Oysters, Cuttle-fish, Devil-fish, and their relatives. They are soft-bodied creatures, with no internal skeleton, but usually with an outer covering called a shell. Sometimes this shell is a mere remnant, so to speak, as, for example, that of the slug.

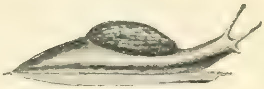
The Slug. Under boards, in moist places, are often found soft, slimy, greyish-colored, or black animals, about an inch long, with a flat under surface and a rounded upper surface. One end of the body, the head, is blunt and rounded ; the other, the tail, is tapering. But this appear-

ance of the animal is subject to change. Slugs are erroneously thought to be dangerous and are called "Blood-suckers."

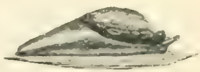
A few of them kept in a glass bottle will interest nature students for some days. At first sight they appear to have no appendages. You will, however, find that they are well provided with them, but that they protrude them only when travelling or when preparing to travel.

Travelling.

Observe the appendages to discover their use and their mode of expansion and contraction. Examine with the aid of a hand-lens the ends of the longer pair when fully expanded. You will observe a dark spot at the end of each. These are the eye-spots. Touch one of these with your pencil. What is the result?



Looking about.



Peeking.

Instead of covering the eye with a lid as we do, the slug pulls its eye back into the body, just as the finger of a glove may be pulled back into the body of the glove. Compare this action of the eye with the inturning of a glove finger.

Examine the opening on the right side of the body and describe it. It opens and closes regularly. What is it for? It opens into a cavity which answers the same purpose as our lungs.

A Safe Descent.

Slug in Various Positions.

Examine the left side of the body just opposite the opening on the right side. The rhythmical motion indicates that the heart is underneath. The heart has only two chambers, instead of four as our hearts have.

The slug slides along a smooth surface, without any apparent propelling force, and in its wake leaves a slimy track. If, however, you examine its underside as it glides along a glass surface, a wave-like, muscular motion may be plainly seen. The same motion is very apparent when the slug is turned over on its back and attempts to regain its normal position.

While observing this motion you may see its mouth, which is on the underside. It is very small and is provided with a rasp-like organ (radula), "one of the most wonderful dental apparatuses known to science," which enables it to 'chew' leaves and soft vegetable tissues such as tomatoes and lettuce. This radula moves forward and back against the hard jaw of the slug like a saw in the hands of a carpenter.

There is a small, flat shell just under the skin of the back. It is probable that at one time in its history the slug had a complete shell, like the snail; but now that it lives under boards which protect it, the shell is unnecessary and accordingly remains undeveloped.

In handling the slug you cannot help noticing the milky excretion with which it covers itself. This, perhaps, is a protection against enemies, and certainly is a provision against cold.

The Snails differ from the slugs, chiefly in the possession of a complete shell, into which they retreat when resting, or during winter. The shells of different species vary much in appearance, but nearly all are more or less spirally twisted either to the right or to the left.

It is sometimes thought that a slug is a snail which has escaped from its shell. The shell of a snail, however, is closely attached to the body and is always carried about with it. Empty shells are frequently found but they are the shells of dead snails, not of living ones.

The illustration is that of the common snail. It may be found among the leaves, around old stumps and logs, in the woods. Other forms, differing in minor details, may be found under boards, etc. The collection and comparison of these forms will prove interesting nature work.

Common Land Snail.

Look for the respiratory opening under the edge of the shell. Compare the eyes, mouth, and mode of locomotion of the snail with those of the slug.

Obtain empty shells and examine their interiors. Study the living animal in order to discover how it is attached to the shell.

Remove the shell from a dead specimen by carefully breaking it away, bit by bit, with strong forceps. Compare the shell-less animal with the slug.

When cold weather comes on, the land snails close up the opening of the shell by a secretion which hardens and forms a transparent wall. Sometimes two or more of these walls may be formed, with air spaces between, after the manner of double doors or windows. Some snails eat these doors when they revive after their winter sleep.

The land snails and the slugs deposit their eggs under damp leaves and stones. The eggs are pearly looking objects about the size of the small letter "o" on this page. It requires twenty to forty days to hatch them out. Try to observe the process of hatching.

Some species of snails live in lakes and streams. The sand of the lake shore usually contains a great number of empty shells. The living specimens may be found in the water. The commoner ones are indicated in the illustration, page 108.

The eyes in these species are situated at the base of the tentacles instead of at the apex as in the land snails. The tentacles are flat and tapering.

Note that the opening of the shell of Physa is to the left, while that of Limnæa is to the right.

WATER SNAILS.

Planorbis. Limnæa. Physa. Goniobasis.

When studying water snails, see whether they come to the surface for air or not.

The eggs of water snails are attached to submerged stones, stems, or leaves.

The water snails bury themselves, if the water dries up, and wait for the wet season. They are active in water even at freezing point.

Operculum (op) of Triton on the foot.

The marine snail, Triton, has a permanent door (operculum), which closes the opening of the shell as soon as the body is withdrawn into it.

The Whelk is a common marine Mollusk.

Natica is a large Mollusk "common between tide marks from Labrador to Georgia." It has a large porous foot from which water pours, as if from the 'rose' of a watering pot, when the animal is picked up. It has no eyes.

The Pearly Nautilus is a beautiful marine relative of the snail, but much more highly organized. "It lives among coral reefs at varying depths." Oliver Wendell Holmes says of it :—

"This is the ship of pearl, which, poets feign,
Sails the unshadowed main—
The venturous bark that flings
On the sweet summer wind its purpled wings
In gulfs enchanted, where the siren sings,
And coral reefs lie bare,
Where the cold sea-maids rise to sun their streaming hair.

"Its webs of living gauze no more unfurl;
Wrecked is the ship of pearl!
And every chambered cell,
Where its dim dreaming life was wont to dwell,
As the frail tenant shaped its growing shell,
Before thee lies revealed,—
Its irised ceiling rent, its sunless crypt unsealed.

"Year after year beheld the silent toil
That spread his lustrous coil;
Still, as the spiral grew,
He left the past year's dwelling for the new.
Stole with soft step its shining archway through,
Built up its idle door,
Stretched in his last found home, and knew the old no more.

"Thanks for the heavenly message brought by thee,
Child of the wandering sea,
Cast from her lap forlorn!
From thy dead lips a clearer note is born
Than ever Triton blew from wreathéd horn!
While on mine ear it rings,
Through the deep caves of thought I hear a voice that sings:

"'Build thee more stately mansions, O my soul,
As the swift seasons roll!
Leave thy low vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea.'"

Note the several successive cavities in the shell. There are but two species of Nautilus at the present day, while,

Chambered Nautilus, showing the internal structure of the shell.

in past ages, there were fifteen hundred species which are now extinct.

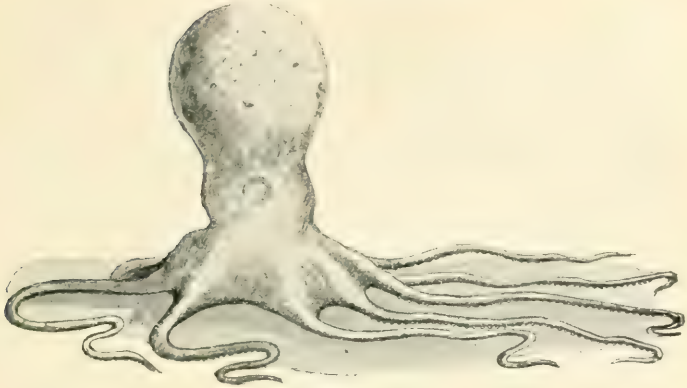
The Devil-fish is a marine Mollusk, destitute of a shell, but provided with eight long and powerful tentacles. Each tentacle has two rows of suckers, twenty-five in each row, by which the animal attaches itself to its prey in order to kill it. These eight tentacles give the name Octopus (eight-footed) to the animal.

"Those weird, horrifying creatures, the Octopi, are very soft-bodied and live on shore just below or at low water mark, or in deeper water. They have no shell. An Indian woman at Victoria, Vancouver Island, in 1877, was seized and drowned by an Octopus."—*Packard.*

One species measures, when full grown, fourteen feet from tip to tip of the outstretched arms.

In San Francisco they are eaten by the Italians and Chinese.

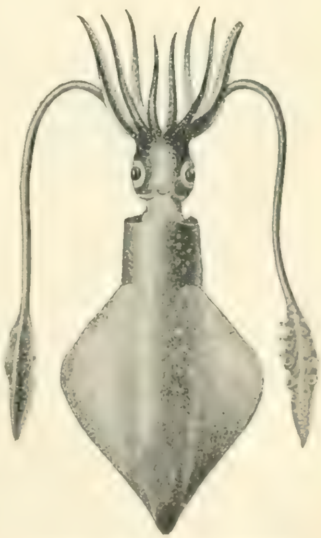
See *The Toilers of the Sea*, by Hugo, for a description of



Devil-fish.

a fight with one of these monsters. The passage is given in the Fourth Reader.

Closely related to the Octopus or eight-footed Mollusk are the cuttle-fishes and squids or ten-footed Mollusks (Decapoda). Loligo is a common representative of the squids.



Common Squid (Loligo vulgaris).

On the underside of the Devil-fish and Loligo is a funnel from which water is ejected. The force of this current against the sea water propels the animal backwards at a fairly rapid rate. Note the highly developed eyes, and the neck, around which is a loose fold of skin called the mantle.

The Limpets, which cling to rocks on the sea-shore, are

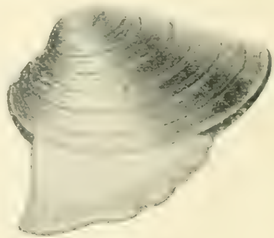
Mollusks whose shells are not spirally twisted. It requires a force of sixty-two pounds, or one thousand nine hundred and eighty-four times its own weight to detach a limpet from a rock.

The Clam. On the sandy bottoms of shallow water in lake, river, or creek, you will often see a V-shaped groove. Follow this groove for a few feet and you will find the engineer of this miniature ditch, probably half-buried in the sand. It is a clam.

Why, and with what instrument, does it make this ditch? The instrument is called a 'foot,' but it is, in reality, the body of the clam. However, as it travels about upon this part of its anatomy, it, at least, fulfils the purpose of a foot.

Observe the motion of the clam as it pulls itself along upon this 'foot.'

Clam, with shell removed from one side.


Clam, foot protruding.

The term 'snail-pace' has become proverbial for slowness, but, compared with a clam, a snail is as the express train to the stage coach.

It is interesting to ascertain from your own observations the rate of speed of the different animals. Compare the speed of the different Mollusks.

Pick up the clam and observe how it withdraws its foot into the shell. Try to open the shell. You cannot do so because muscles (*m. m.* in figure), passing from one half of

the shell to the other, hold them shut. When the clam is dead the shell will open of itself.

The clam can be killed by being placed in spirits or in hot water. The former is probably the more humane method of killing one, though it causes the body to contract very much.

The body of the adult clam is a soft, 'plough-share' shaped mass, of a whitish color. There is no head, and eyes, ears, and nose are also wanting. A nerve centre in the 'foot' is generally believed to perform the function of a hearing organ, and a few spots on the mantle's edge, at the hinder end, are believed to be sensitive to light, but in both of these organs the sensations received must be very vague indeed. In fact, the animal has little need of sight or hearing as it is protected by its shell and brings food to itself instead of going after it.

There is a mouth just under the muscle which crosses from one valve of the shell to the other, at the front end. On each side of the mouth is a gill-like flap (page 112). These flaps by constantly moving keep up a current of water towards the mouth, and the animal obtains its food from the water as it is brought to it in this current.

Two flat, leaf-like gills hang down on each side of the body and outside these there is an outgrowth of the body called the 'mantle,' which completely covers the body and gills. The shell is attached to this mantle, except at its edge.

If a live clam is placed in water and a few drops of ink are introduced near the smaller (hind) end of the clam, a current of water will be seen to flow between the two valves of the shell at and below the point indicated by the lower arrow in the drawing (page 112), and out at the point indicated by the upper arrow. The edges of the mantle will be seen to form a sort of tube at each of these points. In some related species, *e.g.*, Mya, the common marine clam, there is

an extensible tube divided into two parts by a longitudinal partition. A current of water passes down one side of this tube and up the other.

This current of water flows over and through the gills, and is caused by the sweeping movement of thousands of minute hairs (cilia) on the surface of the gills. The blood is aerated in the gills by the oxygen dissolved in the water. The same current carries food particles which are swept into the mouth by the labial palps.

The eggs of the clam are deposited in the outer gill on each side. When these eggs hatch, the gill becomes greatly distended and has a reddish color as if highly congested. The drawing shows the appearance of the young, under the microscope, at their most advanced stage in the gills. Examined with the naked eye they appear like red grains of sand.


Young Clams from gill of adult, much enlarged.

When the young clam leaves the gills of the parent, it attaches itself to some part (gill, skin, or fin) of a fish, where it develops into a form more like the adult. During this period of its life the clam is a parasite, but unlike the ordinary parasite, it continues to develop. When capable of a free existence, it drops from the fish and gradually assumes the adult form of the clam.

The Oyster is a Mollusk which can be obtained, minus the shell, in any part of the country. Compare it with the clam.

"Canadian oysters are incontestably the most luscious bivalves in the world."

The fact that their spawning and brooding season extends from May to September accounts for their absence from the markets during that period.


The Oyster.

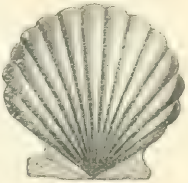
The development of the oyster is more rapid than that of

the clam. They swim about for a short period of time, and then they become fixed to the bottom of those parts of the ocean which are suitable for their existence.

The two parts of the shell are unequal. They are held together by only one muscle.

The Mussel.

The Mussel is perhaps the most common seaside form. These Mollusks are found along the shore at low water. They are eaten in Europe and are used for bait in fishing.



The Scallop.

The Scallop is not only common on the seashore but the shells are often taken to inland parts for ornaments. It is a rapid swimmer, propelling itself by opening and closing its shell.

All of these will be found to have features in common with the clam. Examine each part as indicated in the study of the fresh-water clam.

"I would not enter on my list of friends,
Though graced with polished manners and fine sense
Yet wanting sensibility, the man
Who needlessly sets foot upon a worm.
An inadvertent step may crush the snail
That crawls at evening in the public path ;
But he that hath humanity, forewarned,
Will step aside and let the reptile live."

THE STUDY OF ARTHROPODS

The Arthropods are those animals which have several appendages, each with many joints. The name is derived from this characteristic. This class includes Shell-fish, Spiders, Insects, and Thousand-legged Worms.

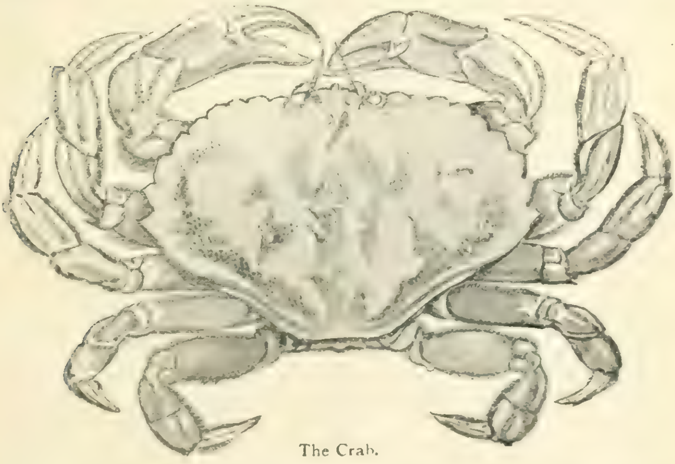
The Crayfish.

In place of the internal skeleton (endoskeleton) of the Vertebrates, they nearly all have a more or less hard external covering (exoskeleton), which gives the body stability and also gives attachment to the muscles. This exoskeleton is most complete in the Crayfish, Crabs, and their relatives, commonly known as Shell-fish, though they are not fish at all. Most of them live in water and breathe by means of

gills, but here the resemblance to fish ends. They have neither scales nor back-bone ; in fact they differ from true fish in nearly every particular.

THE SHELL-FISH OR CRUSTACEANS

The Cray-fish is the common fresh-water type of these hard-shelled, many-legged animals. It is usually called a crab, but has many features which distinguish it from that animal.



The Crab.

The Lobster, a marine form, is larger than the crayfish, but is almost identical with it in structure. The great size of the lobster makes it a valuable animal for food. Thirty million pounds of lobster were caught in 1000 in this country, and this industry employs over eighteen thousand people in the Maritime Provinces.

(The following applies to either Crayfish or Lobster.)

The striking feature of these animals is the large number of appendages twenty pairs. On some of these the animal walks ; with some it swims ; with others it brings food to the

mouth; with others it feels, and on one pair the eyes are situated. This is a wonderful adaptation of structure to environment.

In order to learn which appendages serve the different purposes, a living specimen must be studied. In water observe how it swims, forward and backward. Examine the appendages on the abdomen. All are somewhat leaf-like, but the last pair is very large and flat. These, with the last segment of the abdomen, form a powerful tail-fin.

Take the animal from the water and observe its mode of locomotion on land. How many pairs of appendages does it use in walking? These appendages are called the walking-legs. The first pair of these will attract the attention at once on account of their size. Count the number of joints in one of these. Let the animal take hold of your finger or of a small stick. How does it do so? Examine the ends of the other walking-legs. How many are like the first pair?

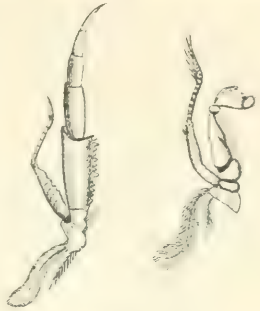
On the head are the eyes, placed at the ends of short, jointed appendages, which give the animal a large range of vision. Each eye is made up of a great number of simple eyes, but these parts can not be seen without a microscope.

In front of the eyes two pairs of thread-like structures may be seen. One pair (antennæ) is much longer than the other pair (antennules). They are tactile organs like the whiskers of a cat. Study the movements of each in a living specimen.

On the under side of the base of each antennule there is a small opening which leads into a hair-lined cavity. These cavities are the organs of hearing, although we can scarcely call them ears as we usually understand the term.

Around the mouth, which opens on the under surface of the body, there are six pairs of appendages, which aid the animal in securing and crushing the snails, insects, etc.,

which constitute its food. Try to separate one of the largest of these appendages from the others; remove it from the body and examine it. It is considered to be a typical appendage, all others being looked upon as modifications of this type. The two largest are shown in the figure.



Appendages of Crayfish.

The appendages then consist of six pairs of swimming appendages, five pairs of walking-legs, six pairs around the mouth, two pairs of feelers, and one pair of eye-stalks, making twenty pairs in all.

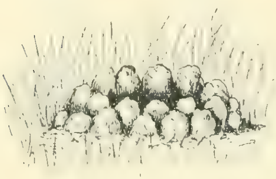
As the crayfish lives under water nearly all the time, it must be provided with gills. They may be found between the shell and the body, along that part to which the walking-legs are attached. Some of the gills are attached to the body and some to the bases of the appendages. There are seventeen pairs of gills in the crayfish (the lobster has eighteen pairs). A current of water is kept flowing over the gills by the constant movement of one of the six pairs of appendages which surround the mouth.

The presence of this current may be shown by placing a drop of ink in the water, just in front of the head. The rapid movement of the appendages which cause the current may be seen especially when the animal is walking on a slippery surface under water.

The body itself is readily seen to be divided into two parts; the front half, which is undivided, and the back half, which is divided into seven ring-like parts (segments), movable upon each other. The front half includes the head and thorax, which together are called the cephalothorax. The rest of the body, the segmented part, is called the abdomen.

The advantage of this segmented part in swimming backwards is evident.

One species of crayfish is found in running water, under stones and other objects. Another species digs holes, known in some parts as "snake holes." They dig to a depth of four feet or more and always leave a pile of earth around the entrance, much as shown in the drawing. This species differs from the one found in the streams, not only in its habit of burrowing, but in the structure of the second pair of walking-legs. These are stouter and provided with a brush of hairs on the second last division. The species found in streams soon dies if kept in stagnant water, whereas the burrowing species may be kept for months without difficulty.



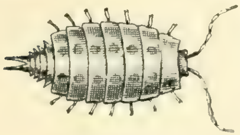
Crayfish Burrow.

The eggs may be found, in spring, attached to the abdominal appendages (swimmerets), and, after hatching, the young crayfish cling to these swimmerets until they have attained the adult form, which they do only after a series of moults.

The adult crayfish never gets over this moulting habit, but casts its shell annually. The shell splits down the back, and the animal pulls itself out of its old home and remains in some sheltered spot until its outer covering is again hardened sufficiently to protect it from its enemies. In this process of moulting, a leg may be broken off, but the crayfish can grow a new one in its place. Individuals are often found with one or two appendages wanting, or with one appendage much smaller than the others, which tells a tale of past adventure or accident. The cast-off shells may be found in streams.

THE WOOD-LOUSE

The Wood-louse, a relative of the crayfish, makes its home on land, under boards and in decaying wood. Often several dozen of them, varying in size and markings, may be found under a single board, where they seem to live in perfect harmony with the slugs and the thousand-legged worms.



The Wood Louse.

The body is oval in outline and is uniformly segmented throughout. Count the number of divisions or segments and the number of legs. Note the same kind of jointed legs as are found on the crayfish. How are these animals adapted to their mode of life? How do they protect themselves from their enemies? Throw one into the web of a funnel-web spider to see how it protects itself.

As it lives on land it cannot breathe by gills, but on the under side of the abdomen (last four segments), there are breathing organs of a whitish color. These are connected with the two processes, shown in the drawing at the hind end. The rhythmical motion of the breathing organs may be seen with the aid of a lens.

The single pair of feelers is situated on the head. They are jointed like the walking legs. The eyes are situated at the bases of these feelers.

The Wood-louse may be obtained for study at any season of the year. In winter they will still be found under boards and boxes, quite active notwithstanding the frosty weather.

A common, fresh-water Crustacean is found in rain-water barrels, along with the wrigglers. Because it has but one eye, it is called Cyclops. Another species, Daphnia, may also be found, but it is too small for examination without a microscope. Both are found in ponds and streams.

Cyclops. Daphnia.

Shrimps, Prawns, Lobsters and Crabs are marine forms. They may be studied as outlined for the Crayfish.

THE SPIDERS

The Spider gave man his first lessons in spinning, and however he may have profited by his teaching and improved his methods, he still finds it impossible to spin as delicate a thread as this little animal. Spiders are often feared, but Comstock says, "If an observer will refrain from picking up a spider, there is not the slightest danger of being bitten by one; and, excepting a single uncommon species, no spider is known in this part of the country (New York State), whose bite would seriously affect a human being."

There is no excuse for not observing the spider and its work. Cobwebs can usually be found in some corner of the house, summer and winter. If we step outside we are sure to come face to face with those wheel-shaped structures, which have excited admiration in the minds of all observers of them. If we walk afield in the early morning before the dew has been dispersed by the sun's rays, the grass will be seen to be carpeted with "little sheets of glistening silk, the webs of the Grass Spider."

The Garden Spider.

Later in the day we shall probably be annoyed by a floating string of silk, apparently attached to nothing, wrapping itself about our heads; but somewhere in space at the end of this string, a Ballooning Spider is or has been attached.

On bushes and sides of buildings irregular webs of tangled thread may be seen, or "between the twigs of a dead branch of pine or hemlock," the geometric web of the Triangle Spider may arouse our curiosity. I have found the latter attached to fences.

To learn late in life from other observers that the accepted explanation of a familiar phenomenon is false, fills one with a sense of loss. What joy might be ours, if we could make the discovery for ourselves! But we guess at the explanation and lose the joy. Such is my feeling regarding the work of the Grass Spider, whose funnel webs seem to be made anew each night to be destroyed by day, whereas the dew makes visible that which, when dry, escapes the careless observer.

You may find funnel webs of a related species in the angles of buildings and fences. Any garden fence will have several such webs attached to it. The long-legged, brown spiders lurk in the funnel at the angle made by the boards with the post, and rush upon their prey when it becomes entangled in the web.

If you want to see the spider in the open, throw a fly into the net and note the cordial welcome of the poor little fly into the parlor of the spider. It is literally received with open arms and jaws. In fact, the movement of the spider is so rapid that there is no time to make careful observations. A small earth-worm or a wood-louse will require more time and the contest in this case will probably end in the escape of the captive. The fiercest fight will take place when Greek meets Greek. Throw another spider into the web and you will witness a furious conflict. The result will depend upon circumstances, but one or the other will be killed, and the body will be actually enclosed in a web woven about it by the conqueror. The way in which this is done is worth observing.

The funnel has a back-door exit for retreat from danger and also for the convenience of the owner in casting out the worthless carcasses of its victims. These carcasses may be seen on the ground beneath the funnel.

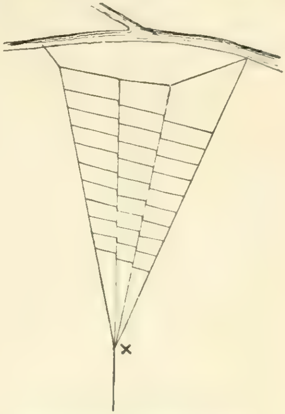
The Cobweb Weavers are responsible for the cobwebs most frequently found in the corners of rooms. They are not so regular as the webs of the Funnel-web Spiders, though sometimes a funnel-shaped retreat is provided, if there is no convenient corner in which to hide. These spiders run back downwards on their webs. Other species spin webs on bushes.

The spiders which construct the wheel-shaped webs in our gardens and around our houses almost everywhere, are known as the Orb Weavers. The web needs no description. Examine it for yourself. Watch a spider making it. When it runs over the web, does it step on the radii or on the spiral? Touch the radii with your lead pencil, then touch the spiral. What is the difference? Which will entangle the fly? On which can the spider run most easily? Is the whole spiral continuous and of the same kind of thread? Are the centres of different webs alike?

In spinning its web, the Orb Weaver lets the wind carry the first stay-threads from the point where it is sitting. They become attached to some support and the spider then pulls in the slack and the threads are made taut. The placing in of the radii is a rather complicated task and can be understood only by observation. You will understand the use of its many legs after you have observed the weaving. Where does this spider wait for its prey?

A large yellow and black spider (Argiope) spins an orb-web, but weaves a zig-zag band from top to bottom along one of the diameters. The spider then takes up its position in the centre of the web, head downwards, and waits quietly for its prey. I have seen this spider keep this position for many days, notwithstanding my close examination. I have wondered if it does not get most of its food at night, as it seems so quiet by day, refusing to move even when the web is agitated with a stick.

The Ballooning Spider spins out a thread when it is perched on some high point. This thread is carried off by the wind until it is long enough for the force of the wind upon it to support the spider, which then lets go its hold and is carried away through the air for long distances. This ballooning seems to be practised by the young of many different families of spiders.



Web of the Triangle Spider.

The Crab Spiders are so named from their resemblance to crabs. One species lives in flowers, with the colors of which it closely corresponds, and catches the insects which come there for the nectar. Thus death lurks for them where life was sought.

The web of the Triangle Spider is apt to be mistaken for a remnant of a web of an Orb Weaver, but the figure will show the distinction. The spider remains at x and thus feels any vibration of the web caused by a victim striking it. By changing the tension of the net, the spider aids in entangling its prey.


Jumping Spider.

The Jumping Spider is a common species. It does not spin a web but secures its prey by springing upon it. It is dark colored, and has a rather square-shaped head. Two of its eight eyes are very prominent, and this gives it a sprightly look quite unusual in spiders.

The Running Spiders are large, dark-colored, hairy spiders, often found under stones and rubbish. They capture their prey by running after it. The females of the genus Lycosa drag their egg-sacs after them, and when the young hatch, they climb on their mother's back.

In tropical countries, the Tarantula, the largest spider known, is found. It sometimes comes to our northern countries in bunches of bananas, but every spider in a bunch of bananas is not a Tarantula. The Tarantulas are very hairy creatures.

The Trap-door Spider of tropical countries is a mechanic. It digs a hole in the ground, in which it builds a nest. The opening is provided with a door, which is properly hinged. On the underside of this door two small holes are made, by which the spider pulls to its door and holds it shut.

After the webs have been studied, the attention should be directed to the spider's structure. Note its two-parted body, four pairs of legs, its mouth parts, its eyes. As in the crayfish, the head and thorax are closely joined together, while the abdomen is united to the thorax by a very narrow junction. The legs are made up of many parts, jointed together. Count the number of joints. The eyes are usually eight (sometimes six) in number and so disposed as to take in a large range of vision. Their exact arrangement is of great importance in classifying spiders. A hand lens will be needed in studying them. About the mouth are two pairs of jaws; the mandibles, which are hard and strong for biting and poisoning, and the maxillæ, which have long, jointed feelers. These are sometimes so long as to be mistaken for legs.

On the underside of the abdomen, near its union with the thorax, the breathing organ is situated. It consists of a number of thin plates, placed side by side.

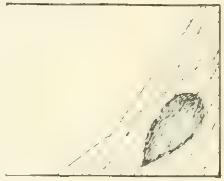
The spinnerets may be examined with the aid of a lens, and the process of spinning should be closely observed. Under the microscope different kinds of thread may be distinguished.

Spiders lay their eggs in masses in silken sacs. Some of these are simply disk-shaped objects, attached to stones, old

fences, etc. They have the appearance of large caps for toy pistols, being thicker in the centre than at the edge.

The eggs of the Cobweb Weavers and of the Orb Weavers are deposited in pointed, oval-shaped sacs. These may be found in August and in the autumn months.

It is possible to keep these sacs for winter study. One sac may be sacrificed to discover the number of eggs, five hundred or more. Keep other sacs in a warm room. Open one in such a way as to expose its interior, but so that it may be closed again. Examine it at intervals during the winter.



Spider's Nest.

"If egg sacs of this kind be opened at different times during the winter, the spiders will be found to increase in size but to diminish in numbers, as the season advances. In fact, a strange tragedy goes on within these sacs; the stronger spiders calmly devour their weaker brothers, and in the spring those that survive emerge sufficiently nourished to fight their battles in the outside world."—*Comstock.*

With such a schooling in the nursery we shall not be surprised to learn that the adult spider is a most bloodthirsty animal, preying upon its own species, as well as upon flies and other insects. Nor are the family relations of the adult spiders any happier than those of the nursery. The female spider is the ruler and compels her mate, who is much smaller, sometimes less than half her size, to fight for his life or to escape by his agility or by strategy, from her murderous jaws. The care which she devotes to her eggs is her only redeeming feature, except that she is beneficial in aiding the housekeeper to keep down that household pest, the fly.

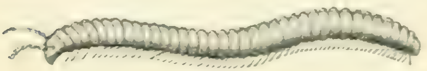
Daddy Longlegs, or the "Harvestmen," are near rela-

tives of the spiders. Head, thorax, and abdomen are all united, while four pairs of very long, delicate legs make rapid locomotion possible. These harmless animals are often cruelly treated by children, who catch them and demand from them, on pain of death, the whereabouts of mythical cows. In escaping from its captor, the animal is sure to leave a leg or two as forfeit for its failure to meet the demand.

Some relatives of the spiders are parasites. Itch is caused by a small animal, something like a spider, which burrows under the skin. The Sugar Mites, Cheese Mites, Cattle Ticks are likewise parasitic spiders.

THE THOUSAND-LEGGED WORMS OR MYRIAPODA

The Millipedes and **Centipedes** are found under old logs and boards. They have the hard-shelled body like the crayfish, but the body is uniform throughout. The millipedes are cylindrical and have two pairs of legs on each division (segment) of the body, while the centipedes have flattened bodies which are smaller than the former. They have but one pair of legs to each segment.



The Millipede.

These animals should be handled with care, as the centipedes, at least, are poisonous.

THE STUDY OF INSECTS

Two hundred thousand species of insects are known! In the face of this fact we may feel some hesitation in attempting to make their acquaintance. The careful study of a few types, however, will enable us to recognize and understand all which may come under our observation.

The Insects may be grouped as follows :—

1. Butterflies and Moths. *Lepidoptera.*
2. Flies and Mosquitoes. *Diptera.*
3. Dragon-Flies, etc. *Neuroptera.*
4. True Bugs, Plant Lice, Cicadas, etc. *Hemiptera.*
5. Grasshoppers and Crickets. *Orthoptera.*
6. Beetles. *Coleoptera.*
7. Ants, Bees, and Wasps. *Hymenoptera.*

The class-names refer to peculiarities of the wings. The Lepidoptera have wings covered with minute scales. The Diptera have two wings only, the second pair being rudimentary. The Neuroptera have transparent wings in which the veins show plainly. Hemiptera means half-wings, the basal half of the first pair being thickened, and only the terminal half wing-like. The Orthoptera fold their wings straight, hence the name, from *orthos*, straight, and *pteron*, a wing. The Coleoptera have the outer wings thickened to form sheaths; *coleos*, a sheath. The Hymenoptera have membranous wings; *hymen*, membrane.

I. BUTTERFLIES AND MOTHS. (Lepidoptera)

The Butterflies. Let us begin with the butterflies. Even so cumbersome a tool as a straw hat may bring about an

introduction to a butterfly, but a net of green tarlatan two feet deep, on a ring of stout copper wire a foot or more in diameter, and attached to a light handle about five feet in length, is the more satisfactory weapon. Once in the net a drop of chloroform will stop all fluttering and thus prevent the destruction of the delicately painted wings. From the net the butterfly should be transferred to the poison-bottle. This is a wide mouthed bottle with tightly-fitting cork. Place a lump or two of potassium cyanide, a deadly poison, in the bottom, cover with water and add plaster of Paris enough to take up all the water. The whole will then set and hold the poison in place. (For further instructions regarding collecting and preserving, see Appendix).

Knowing that all the great variety of color in the butterfly is due to extremely delicate scales, which seem like finest powder to our gross touch, we will handle carefully these gaudy, gauze-like creatures.

The sunny hours of June, July, and August are the sporting time of butterflies, but some may be found in the woods in early spring, sipping the sap from the maple and other trees, and some will linger to flutter above the very latest blossoms.

Moths haunt the night and may be collected successfully around lights, or may be attracted, by a mixture of sugar, rum, and some volatile oil, to any selected spot upon which the mixture may be smeared, *e.g.*, tree trunk, or fence.

Butterflies and moths are distinguished by their color, size of body, and by their antennæ. Moths are duller in color, have stouter bodies, and feathery antennæ. The antennæ of butterflies are thread-like with knob-like enlargements at the outer ends.

METHOD OF STUDY

To meet butterflies, we must visit their favorite haunts. The clover field is sure to have the Monarch, the Viceroy, and the Clouded Sulphur, flitting over the fragrant blossoms. At evening the Thistle Butterfly is almost sure to be found on the blossoms of the plant which gives it its name. There, intoxicated with sweets, and drowsy with the coming on of night, this beautiful butterfly may be easily captured without a net. We have all noticed the swarms of yellow butterflies about the drying water puddles, and the white butterflies which visit the cabbages of our gardens, to deposit their eggs upon the plants which will furnish their young with food. Over the parsley and carrot beds the Asterias or Eastern Swallow-tail hovers to deposit her eggs, knowing well that the larvæ need these plants for food ; and decaying apples are sure to attract the Question Sign and the Mourning Cloak.

There is a species of milkweed, known as butterfly-weed, and the collector can do no better than to discover a clump of these plants and wait patiently for his victims to come to him, rather than, as is often thought necessary, to chase wildly "o'er moor and fen" only to be baffled at last by a barbed-wire fence or an impassable stream.

For the student of limited experience and knowledge, it is better to pursue a method of study which is almost wholly dependent on keen observing powers, as outlined in the subsequent study of the common Eastern Swallow-tail. Begin by collecting the larvæ which may be fed and observed through all their wonderful changes. If the larvæ are feeding when collected, the collector should note the food-plant

in order to supply it as needed. Boxes with glass tops or covered with wire netting will serve for rearing larvæ, or one large *terrarium* may be made, in which earth and growing plants may be kept.

The terrarium consists of a large box with glass sides, board bottom, and a top of wire netting. In this, larvæ, cocoons, and butterflies, and even larger animals, such as toads, crayfish, etc., may be kept for the purpose of studying their habits.

THE LIFE STORY OF A BUTTERFLY

As a type of all other butterflies, we shall describe the life of the Eastern Swallow-tail, or Asterias Butterfly. (See page 134.)

Some day in August you may see this butterfly hovering over the parsley or the carrot bed, apparently in doubt whether to alight or not, and quite regardless of your presence or attention. But it does not alight. You will, however, see it bend its body around to the underside of the leaf, pause a moment and then flutter on. By observing the exact spot where the butterfly touched the undersides of the leaves you will be able to collect a few eggs, one from each leaf, for the butterfly is depositing its eggs when it acts as described above. Remove the leaves bearing the eggs to your breeding box or terrarium, noting the date of their being laid. Examine daily. In a week or ten days the little black caterpillar, with its white saddle midway its length, will emerge.

Larva of Eastern Swallow-tail. First stage.

This little baby is called the *larva*, and in this stage it does all its eating. Touch this larva with some object and it will protrude a pair of orange colored horns. These give off a disagreeable odor, which protects it from its enemies.

During its lifetime as a larva, you should observe it closely each day. It casts off its skin several times before reaching the adult larval stage. In this last larval stage the color is usually green, banded with black, in which are orange spots. The orange spots may open into the green, thus dividing the black bands into parts. Another common type has a black body with small orange spots on each segment.

Count the number of body divisions (segments) behind the head. Note the legs on the first three segments. These legs are jointed. On the sixth, seventh, eighth, ninth, and twelfth segments there are fleshy outgrowths which end in hairy disks. These are called pro-legs. Of ,w has but three pairs h- pairs of jointed leg,

6

...stern Swallowtail (*Papilio asterias*) and larva.
...iger Swallowtail (*P. turnus*) and larva.
...spice-bush Swallowtail (*P. troilus*) and larva.
...Giant Swallowtail (*P. cresphontes*) and larva.
...e Harvester (*Feniseca tarquinius*).
...Common Blue (*Lycaena pseudargiolus*).

When the larvae eat..n heartily for to explore the v

transformed into its next stage of existence. Having found a place to its liking, usually on the under surface of a board or branch, it attaches its hind feet to the surface by a little cushion of silk and clings to the board or branch with its feet, in which position it rests for a while.

It next begins to spin a thread of silk which it attaches to the surface on which it rests (see illustration). The process of spinning this thread is very interesting, but must be seen to be understood and appreciated. When the thread has been made strong enough, the larva manages to slip its head through the loop, in which it then rests as an arm in a

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off a disagreeable odor, wh thread with a lens
from its enemies.

Larva of Eastern Swallow-tail. First stage.

The transformation from the chrysalis is the most wonderful of all. The chrysalis splits along the back, and the adult butterfly (*imago*) emerges, provided with wings for flight and with legs for walking and clinging. The female butterfly's wings are not so conspicuously marked with yellow spots as those of the male in this species.

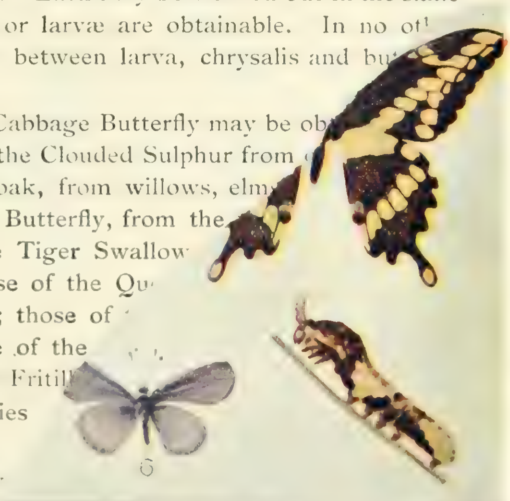
All these stages may be observed in the breeding box or terrarium. Eggs may be procured in June or August. The butterfly itself may be taken at any time from June till September, while the larvæ may be found on parsley or carrots until October.

All butterflies have a life history similar to that of the Eastern Swallow-tail. Each may be worked out in the same way when the eggs or larvæ are obtainable. In no ot[h]
way can the relation between larva, chrysalis and bu[tterfly]
be so well learned.

The larvæ of the Cabbage Butterfly may be ob[tained]
cabbages ; those of the Clouded Sulphur from
of the Mourning Cloak, from willows, elm
those of the Thistle Butterfly, from the
nettle ; those of the Tiger Swallow
and other trees ; those of the Qu
hop-vine and nettle ; those of
the milkweed ; those of the
willow ; those of the Fritil

Four great families
Canada :

(1) The Swallow
(2) The Brush-
Fritillaries,
(3) The Blue
(4) The S
The Brush



...stern Swallowtail (*Papilio asterias*) and larva.
...iger Swallowtail (*P. turnus*) and larva.
...Spice-bush Swallowtail (*P. troilus*) and larva.
Giant Swallowtail (*P. cresphontes*) and larva.
...e Harvester (*Feniseca tarquinius*).
Common Blue (*Lycena pseudargiolus*).

others by the fact that, in both sexes, the first pair of legs is very small and useless for walking. Hence these butterflies have but four legs. The males of the third class have a similar structure in the first pair of legs, but the females have six walking legs. The other distinctions of the four classes are in the larvæ and chrysalids, and cannot be dealt with here.

(1) THE SWALLOW-TAILS

The Swallow-tails contain some of our largest butterflies. The Eastern Swallow-tail (Papilio asterias) has several relatives in Canada. A common one is the yellow and black Tiger Swallow-tail (Papilio turnus). Its larvæ feed on various plants, but preferably on wild cherry. A recent ... tor to southern Canada is the Giant Swallow-tail (Papilio ... ntes), whose larvæ sometimes damage the orange ... he south. Other food-plants of this species are ... ash and the hop tree. The most beautiful species ... ush Swallow-tail (Papilio troilus). Its food- ... bush and sassafras, and it prefers a warm ... r would like to hear from collectors ... of these last two species in Canada. ... hites belong to the same family ... hey lack the projection of the ... e to the latter. The Clouded Sulphur is shown in plate. ... food-plant is clover. ... male has a solid black ... on the wings, while ... ts are more distinct ... se of the female. ... bage Butterfly ... s so common

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from its enemies.

Larva of Eastern Swallow-tail. First stage.

1. The Eastern Swallowtail (*Papilio asterias*) and larva.
2. The Tiger Swallowtail (*P. turnus*) and larva.
3. The Spice-bush Swallowtail (*P. troilus*) and larva.
4. The Giant Swallowtail (*P. cresphontes*) and larva.
5. The Harvester (*Feniseca tarquinius*).
6. The Common Blue (*Lycæna pseudargiolus*).

as to almost monopolize the field of study. The male has but one spot on each fore-wing.

A related species (Pieris protodice) is rare. It has rectangular markings instead of the round ones as the Cabbage Butterfly has. Its food-plants are the Cruciferæ.

(2) THE BRUSH-FOOTED BUTTERFLIES

The Argynnis Butterflies have delicate tastes. The larvæ feed on violets, at night, lying concealed during the day. The silvery spots on the undersides of the wings are characteristic. There are several species in Canada.

The butterflies of the related genus, Brenthis, have the same food-plant. Two species, the Silver-bordered Fritillary (1.4-1.7 inches) and the Meadow Fritillary (1.65-1.8 inches) usually fly together. The latter has no silvery spots on the undersides of the wings.

The Meadow Fritillary.

The Pearl Crescent is a common butterfly whose larvæ feed upon the aster and related plants (Compositæ). Expanse 1.25-1.65 inches.

The Question Sign is shown in plate. Expanse 2.5 inches. It is one of our commonest butterflies. The larvæ feed upon the nettle, elm, or hop. The Comma Butterfly is smaller (1.75-2.00 inches) but will be readily recognized by its resemblance to the preceding. The graceful Angle-wing is another relative. These all belong to the genus Grapta.

The Mourning Cloak is shown in plate. It is brownish-black beneath with a grayish-yellow border. We have one related species known as Milbert's Tortoise-shell. The larvæ of both feed on the elm, willow, and poplar. The adults hibernate and are found in the sugar-bush in early spring.

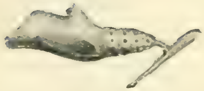
The Monarch or Milkweed Butterfly is perhaps our most

The Monarch Butterfly.

widely known butterfly. The larvæ feed on the milkweed. The Viceroy flies with the Monarch and imitates it closely in color and markings for the sake of protection from its enemies, who will not eat the latter. Its larvæ feed on the willow, and hibernate by rolling leaves together to form cases for the winter. The Viceroy's real relatives are the Red-spotted

The Viceroy Butterfly.

1. Milbert's Tortoise Shell (*Vanessa Milberti*).
2. An Argynnis Butterfly.
3. The Question Sign (*Grapta interrogationis*), larva and chrysalis.
4. The Mourning Cloak (*Vanessa antiopa*), larva and chrysalis.
5. The Pearl Crescent (*Phyciodes tharos*).
6. Silver-bordered Fritillary (*Brenthis myrina*).


Chrysalis of Viceroy.


Larva of Viceroy.

Purple and the Banded Purple, whose larvæ feed on the willow, cherry, and many other plants.


The Red-spotted Purple.


The Banded Purple.

The Thistle Butterfly, the Red Admiral, and Hunter's Butterfly are sure to attract the attention of even the "wayfaring man" because of their numbers and of their beauty. Though they belong to the same genus (Pyrameis) they vary somewhat in their favorite food-plant. The first prefers the thistle; the second, the nettle; the third, the composite plants, cudweed and antennaria. Expanse 2-2.5 inches.

(3) THE BLUES, COPPERS, AND HAIRSTREAKS

The Common Blue is a small butterfly (1.1-1.3 inches), which ranges from Alaska to Florida, across the continent. There are many varieties of it, and it is a type of a large group of butterflies, known as the Blues, Coppers, and Hairstreaks.

The American Copper (expanse 1 inch), is a common butterfly ranging from Hudson Bay to the Ohio River. The larvæ feed on the common sorrel. The Least Copper is its most common northern relative. This is a dull-colored butterfly whose early stages are unknown; (expanse .85-.95 inch).

Chrysalis of the Harvester. (Enlarged.)

The Harvester is bright orange-yellow, spotted with black. The larvæ have the habit, unusual among butterfly larvæ, of feeding upon the mealy bug, a species of plant-louse. The chrysalis is of the nature of a freak, as its upper surface bears a distinct resemblance to a monkey's face. When enlarged it has more the appearance of a mummy's face and as such appears on the front page of the *Entomological News*, 1899.

(4) THE SKIPPERS

The Sooty Wing.

The Sooty Wing (Pholisora catullus) is another small butterfly (expanse 1 inch), which is a type of a large group of dull-

1. The Clouded Sulphur (*Colias philodice*), larva and chrysalis.
2. Hunter's Butterfly (*Pyrameis huntera*), larva and chrysalis.
3. The American Copper (*Chrysophanus hypophlaeas*).
4. The Canadian Skipper (*Erynnis Manitoba*).
5. The Painted Lady (*Pyrameis cardui*), larva and chrysalis.
6. The Red Admiral (*P. atalanta*), larva and chrysalis.

colored butterflies known as the Skippers or Dusky-wings. The larvæ feed, at night, upon the plant known as lamb's quarters. Some class the Dusky-wings with the moths.

There is a strong family resemblance among all the members of this group, the body being very stout for the size of the wings.

Most of our butterflies do not recognize the international boundary line at all, and are as common in Canada as in the United States. But we have one butterfly that seems to prefer Canadian soil and seldom travels south of the 'tariff wall.' This is the Canadian Skipper (Erynnis [pamphila], Manitoba).

The Moths. The moths may be grouped as follows :

(1) The Sphinx Moths.
(2) The Tussock Moths.
(3) The Owlets.
(4) The Geometrids.
(5) The Tiger Moths.
(6) The Giant Silkworms.
(7) The Leaf Rollers.
(8) The Leaf Miners.

It is impossible to state here all the distinguishing characteristics of these classes of moths, but we note the most important. The Sphinx Moths have very long tongues. The larvæ of the Tussock Moths have tufts of hair on the back. The Owlets have stout, tapering bodies and hair-like antennæ. The larvæ of Geometrids 'loop' themselves up when travelling, thus 'measuring off' distance. The Tiger Moths are striped or spotted. The Giant Silkworms spin large silken cocoons. The habits of the larvæ of the last two classes give the moths their names.

The moths should be studied in the same way as the butterflies. Secure their larval forms and rear them in or about

your home. The food-plants of the commoner species are given in the following pages as a guide to the student in collecting the larvæ.

If the cocoons, which contain the chrysalids, are found, they should be kept in a cool place, each in a separate box, until the moths emerge. Many of these cocoons will not produce moths, as the chrysalids may die from various causes.

The spinning of a silken cocoon by the larva when it is transformed to the chrysalis stage is usual with those moths which form the chrysalis above ground. Those which form the chrysalis under ground, *e.g.*, the tomato worm, do not spin cocoons but are enclosed in a tough brown case.

(1) THE SPHINX MOTHS

The Tomato Sphinx Moth lays its eggs on the tomato, potato, and tobacco. In tobacco districts, this moth (or as some claim, a variety of it) is very abundant and flies at dusk and throughout the night. Their swift flight and manner of of poising before a flower to extract the nectar have given them the local name,

Larva of Tomato Sphinx

Chrysalis of the Tomato Sphinx.

'humming birds.' The larva is a large green worm, marked with white stripes along the sides. The chrysalis is formed in the ground.

The White-lined Sphinx Moth lays its eggs on purslane, apple, grapevine, turnips, or buckwheat. The larva is yellowish-green or brown with colored markings. The moth is grayish with white veins. A yellowish band crosses each fore-wing and a broader delicate pink band crosses each hind-wing. The chrysalis or pupa is formed in the ground. It is much like that of the Tomato Sphinx, but the 'handle' is absent.

The Tomato Sphinx Moth.

Both of these moths are attracted by electric lights or other bright lights.

Larva of White-lined Sphinx Moth.

The White-lined Sphinx Moth.

The larvæ of the Sphinx Moths are especially subject to attack by the parasitic Ichneumon Fly, which lays its eggs in the bodies of the larvæ. These eggs hatch and the young fly-larvæ live upon the tissues of the Sphinx larvæ, escaping only to form their white oval cocoons on the body of their host, which may bear several dozen of them. Needless to say the result is fatal to mine host.

Clear-wing or Bee Moth.

A common Sphinx Moth, Clear-wing, which is likely to be mistaken for a bee or a large fly is shown in the figure. The larvæ feed on snow-ball and related plants. The moth flies in the heat of the day in June and July.

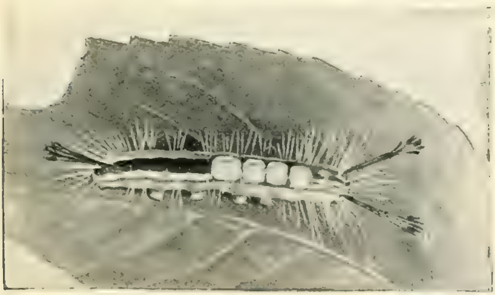
The Plum Sphinx is an enemy of the plum tree. The larvæ enter the ground to change to the chrysalis state.

Chrysalis of Plum Sphinx.

The Plum Sphinx Moth.

(2) THE TUSSOCK MOTHS

The Tussock Moths are becoming widely known, because of their depredations on shade trees in cities. The female is wingless, consequently this pest



Larva of Tussock Moth.

Tussock Moth.
(Male)

is not likely to spread rapidly. The cocoons and eggs should, however, be collected in winter and destroyed.

The Gipsy Moth is a related species, which happily has not yet been introduced into Canada, but in Massachusetts has caused great depredation, though thousands of dollars have been spent in fighting it.

(3) THE OWLETS

Underwing Moths are common night flyers. Their fore-wings usually resemble bark in appearance, while their hind-

An Underwing Moth.

wings are crossed by one or two conspicuous bars of red, orange, yellow, or white. They belong to a very extensive class, the Owlets, which includes the moths of the Army-worm, Boll-worm and Cotton-worm. The larvæ of the Underwings feed on forest trees. One species preys upon the plum.

Note the thread-like antennæ, characteristic of this class.

The moth, whose larva is known as the Army-worm, belongs to this group.

The Army-worm feeds upon grasses. When they have ex-

Moth of the Army-worm.

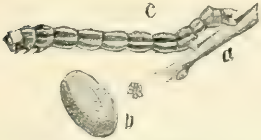
The Army-worm.

hausted the supply in one locality, all the worms move with one accord to another, thus forming a sort of army, which, however, is more like a mob, as there is no discipline in the ranks.

(3) THE GEOMETRIDS

Two species of Canker-worm prey upon our fruit trees. These are the Spring and Fall Canker-worms. The larvæ

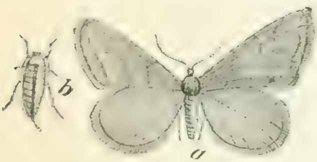
are commonly called measuring worms, or geometrids, because of their mode of locomotion. The body is looped up



Larva and Pupa of Spring Canker-worm.

Eggs and Larva of Fall Canker-worm.

and then extended. Try to discover the cause of this. Another habit, characteristic of them, is their dropping from the tree and suspending themselves by silken threads when the tree on which they are feeding is suddenly jarred.



Moths of Canker-worm.
a Male. b Female.

The female moths of both species are wingless. Accordingly they may be prevented from depositing eggs on a tree by a band of some sticky paper tied about the trunk. Neither the female moths nor the larvæ will cross this.

The larvæ of both species appear in the spring, but the moths of one emerge in the fall, while those of the other emerge in the following spring; hence their names. The moths of the fall species may be seen after quite cold weather and their delicate wings seem poorly fitted to withstand the cold air in which they seem to revel.

(5) THE TIGER MOTHS

The Tiger Moths are well-known in the larval stage. The larva of the Isabella Tiger Moth is known as *the* caterpillar. It is a hairy caterpillar, brown, with black at each end. In the fall it will be seen travelling about very hurriedly. It hibernates in the larval state, and in the spring has a vora-

cious appetite, which it is willing to satisfy with almost anything in plant form.

It soon forms a hairy cocoon (chrysalis stage), and in a week or two the moth emerges. It is small, tawny yellow in color, with a few dark spots on the head, wings and body. It flies at night, and may be taken about lights.

A related caterpillar is known as the Yellow Bear. It is covered with long yellow hairs of uneven length which may vary in color from yellow to brown. It feeds upon almost any herbaceous plant, and is common in September and October. It passes the winter in the chrysalis state. The moth is "pure white, with a few small black spots on the wings, and with orange and black on the abdomen."

Larva of Hickory Tiger Moth.

The Hickory Tiger Moth is another common form. The larvæ feed on hickory, butternut and other forest trees.

The moth is ochre yellow or brown in color, the fore wings dotted with white. It is common about lights at night.

The Harlequin Milkweed Caterpillar is abundant on the milkweed.

The Harlequin Milkweed Caterpillar.

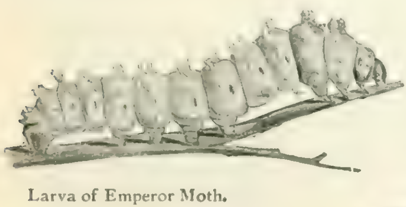
The moth is blue-gray with unadorned wings, but with a yellow abdomen spotted with black. It flies in the summer months.

(6) THE GIANT SILKWORMS

The Cecropia or Emperor Moth is one of the largest species of this or any group. Expanse 6-6½ inches. The eggs are laid on the wild cherry, alder, willow, and many other trees.

Cecropia or Emperor Moth.

The larvæ attain a length of three to four inches and a thickness of three-fourths of an inch. The cocoons are formed on trees and vary in shape. The moths leave the cocoons in May and June. Look for the cocoons after the leaves have fallen.



Larva of Emperor Moth.

The related species are the Polyphemus, the Promethea, the Luna, and the Io Moths.

Cocoon of Emperor Moth.

The Polyphemus is known as the American Silkworm. Expanse 5-6 inches. The eggs are laid in clusters (15 to 20) on the under sides of oak, elm, butternut, maple, or linden

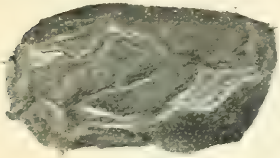
The Polyphemus Moth.

leaves. The larvæ are green. The white, oval cocoons are closely woven, each containing about eight hundred feet of silk, which is suitable for silk manufacture.

The chrysalis has a peculiar habit of shifting about in its

Larva of Polyphemus Moth.

cocoon in a very lively manner, so that one is inclined to drop the cocoon, if handling it for the first time. The moths emerge in May. Look for cocoons among the fallen leaves of its food-plants.



Cocoon of Polyphemus Moth.

The larvæ and cocoons of the Luna Moth are very similar to those of Polyphemus. The moths, however, are strikingly different. They are large and bluish-green in color. The wings bear eye-like spots, with transparent centres. The larvæ feed on hickory, walnut, and birch, and the cocoons will be found among the fallen leaves under these trees.

Luna Moth, fresh from its Cocoon. Tails of hind wings not completely extended.

The Promethea Moth is a day-flier. It 'never takes food and is therefore short lived.' There are two broods, the eggs of the first being laid in May and June, those of the second in

Io Moth. (Male.)

August and September. They are laid in clusters (5-30). The larvæ feed on the wild cherry, sassafras, buttonwood, ash, etc., at night. The cocoons are made in leaves, which remain

Io Moth. (Female.)

on the trees, those of the first brood for three or four weeks; those of the second brood, all winter.

The eggs of the Io Moth are laid in clusters (20-80) on corn, cherry, hop, apple, elm, oak, willow, etc. The larvæ are

covered with spines, whose prick is slightly poisonous, like nettles. The thin cocoons are made among the leaves, on the ground.

Larva of Io Moth.

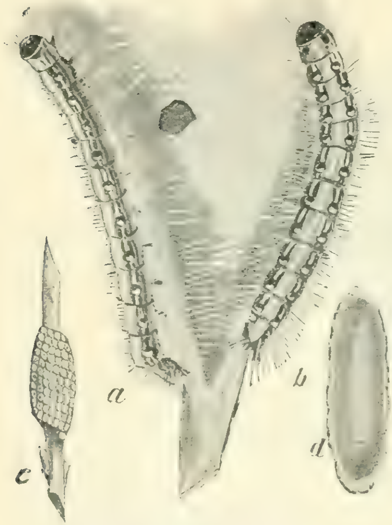
(7) THE LEAF ROLLERS

The social instinct is developed in the Tent Caterpillars. These build cobweb-like tents, which protect the caterpillars from their enemies and from inclement weather.

Female. Male.
Moths of Apple-tree Tent Caterpillar.

In July, the moth of the Apple-tree Tent Caterpillar lays hundreds of eggs in a varnished brown mass, encircling a stem of an apple tree or a wild cherry tree. These eggs hatch in the following spring. The larvæ spin a network of silk in the fork of the tree. In this tent they remain, except in early

morning and late afternoon, when they leave it to obtain food. They usually leave the tent in Indian file, and keep in touch with it by means of threads of silk; each larva spinning out a thread as it moves along.



Apple-tree Tent Caterpillar.
a b Larvæ. c Eggs. d Cocoon.

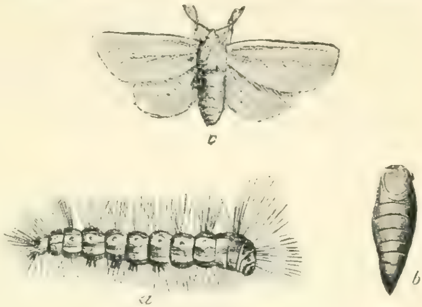
The cocoons are formed under stones, boards, etc. They are oval, and among the threads is a peculiar dry yellow powder. The moths emerge from the cocoons two or three weeks after they are formed. They are small, yellowish-brown in color and each forewing is crossed by two light yellow lines.

The Forest Tent Caterpillar is a related species, which damages orchards as well as forests. It is particularly fond of wild cherry. This species does not build a tent, and it forms its cocoon in the tree. The larva is similar to the preceding, but has a row of spots instead of the white line along the back.

The eggs, tents and caterpillars of these moths should be destroyed whenever found. Trees which are infested should be sprayed with Paris green when the buds appear in spring.

The Cherry Web-worm also builds a tent, but in this case branches and leaves are enclosed and the larvæ do not leave the nest to feed. The chrysalids are formed in the tent.

The Fall Web-worm also builds a tent which encloses twigs and leaves, upon which the larvæ feed, but the chrysalids (pupæ) are formed upon the ground and remain in this state throughout the winter. The moth, which emerges in June or July, is pure white or, in some cases, the fore wings are spotted.



Fall Web-worm. (a Larva. b Chrysalis. c Moth.)

Everybody has made the acquaintance of the larva of the Codling Moth, at least, when too hastily biting an early ripe-looking, windfall apple. Its ravages are also too common in our winter fruit.

The moth is on the wing about the time that the apple tree is in bloom, and deposits her eggs in the upper ends of the blossoms. The larvæ soon hatch and penetrate the fruit, thereby preventing its proper development.

If a bandage of old cotton cloth is tied about the trunk many of the larvæ will be secured in the chrysalis stage and may be destroyed. The bandages should be examined once a week, as ten days is the average length of the chrysalis state. A second brood will be formed if the first is not destroyed. All fallen fruit should be destroyed at once.

Spraying trees with Paris green just after the falling of the blossom will kill the larvæ.

Examine the damage done to a wormy apple. Examine the larva found in an apple.

(8) THE LEAF MINERS

The typical moths of this group lay eggs on leaves and the larvæ mine into their soft tissues.

The Clothes Moth deposits its eggs in furs or in woollens. The larvæ feed upon these, enclosing themselves in a case made of the fur or cloth, just as the larvæ of the caddis-flies enclose themselves in cases of stones, shells, etc. Eventually the larvæ spin cocoons of the fur or wool, thus further destroying the garment.

The moths deposit their eggs in dark places. The remedy is to have light closets or to enclose the garments in air-tight boxes or bags.

II. FLIES AND MOSQUITOES. (Diptera)

The House Fly is common enough, yet few know its life history. The eggs are laid in many places, but preferably, in the cleanings from the horse stables. In twenty-four hours, the eggs hatch out as white larvæ (maggots). In about a week these larvæ pass into the pupa stage—smooth, brown, oval shells, about a quarter of an inch in length. In another week these are transformed into flies.

Since an ordinary female fly lays about one hundred and twenty eggs, and a brood hatches out every two weeks, the number of flies, which may spring from a single individual in the course of a summer season, is enormous.

A few female flies live through the winter in sheltered places, and, in the spring, repopulate the earth with their progeny.

Cleanliness about houses and stables will aid in keeping down their numbers. Chloride of lime should be thrown on the cleanings from horse stables.

Examine the foot of a fly with a microscope to find out *how he crawls up the wall, yet he never falls.*

The eyes are wonderful structures, containing hundreds of parts. A good hand-lens will reveal the simple parts.

There are many species of flies similar to the house fly. **The Stable Fly** is troublesome on horses and cattle. Before

storms it usually enters houses, biting the inmates ; but the house fly cannot bite.

The *big*, *blue*, *buzzing*, *bummy*, *blue-bottle fly* is also well known. It often deposits its eggs in meat.

Mosquitoes. Study the wrigglers found in rain-water. They are the larvæ of mosquitoes. Do they come to the surface for any purpose? Describe all their actions. Try to see one emerge from its larval state as a full-fledged mosquito.

The female mosquito lays her eggs in a boat-like raft on the surface of water in swamps, in puddles, in rain-barrels, etc. These eggs soon hatch into the larvæ, which live in the water. These larvæ have the same number of parts (twelve), as the larvæ of butterflies and moths have. In about a week or ten days the larvæ become transformed into pupæ. These float just under the surface of the water for a few days, after which, under favorable conditions, a mosquito emerges from each pupa.

The male mosquito can be recognized by its feathery antennæ, those of the female being narrow and more thread-like. The female is the one that bites.

The presence of swampy places and stagnant pools of water favors the propagation and increase in numbers of the mosquito, which has been found guilty of causing malarial and yellow fevers. In fact, the organisms which cause these fevers must first pass into the mosquito, there develop for a definite period of time and then be transmitted to man, in order to cause fever in him. Consequently these fevers rage only during the mosquito season, and the extermination of the mosquito would stamp out these fevers.

Coal-oil, poured on the water, will kill the larvæ by cutting off the air supply. The thorough draining of land will help to keep down the number of mosquitoes.

Among the Diptera are a few species which deposit their eggs upon certain plants. The larvæ cause abnormal growths of the plant tissue, which are called 'galls.' The most common gall is the pine-cone willow gall, which is found on the heart-leaved willow. It is quite likely that every young botanist has been deceived by this peculiar cone-like structure which would seem quite in place on an evergreen, but seems entirely out of place on a willow.

Other galls are formed by species of wasps.

The Hessian Fly and the Wheat Midge, both so destructive to wheat in certain seasons are related to the gall-fly mentioned above. The former attacks the stalk, in which it lays its eggs ; the latter attacks the wheat in the ear.

III. DRAGON-FLIES, ETC. (Neuroptera)

Dragon-flies, or Devil's Darning-needles, are familiar

Larvæ of Dragon-flies. Adult Insect emerging on the right.

insects during the summer months. They are quite harmless, notwithstanding the prevailing belief to the contrary.

The eggs are laid in water, in which the larvæ live for a part of two seasons, crawling about in the mud at the bottom or swimming about in the water.

In July or August of the second season the larva crawls out of the water up the stem of some water plant, fixes

Dragon-flies.

itself firmly to it with its six feet, in order to pass into the next stage, that of the winged insect.

The larval shell splits along the back after much squirming and twisting of the enclosed insect, which withdraws itself gradually until it has entirely freed itself. This transforma-

tion usually takes place at night, but you will be able to witness it in the daytime too.

Collect the larvæ of Dragon-flies by scraping up mud from the bottom of ditches and ponds. Keep these in your aquarium until they become transformed. Be sure to supply a support up which they may climb into the air.

The Damsel-flies are similar to Dragon-flies, but smaller and usually more brightly colored. When at rest they fold their wings over the back, while the Dragon-flies always keep theirs as shown in the illustration, no doubt for purposes of protection, as in this position they resemble closely a dead branch with withered leaves.

May-flies are common, especially near bodies of water. At a summer resort, in Ontario, a few years ago, they were scraped up by bushels from the side of the hotel facing the lake. The larvæ live in water under stones, in burrows, or in the open, according to the species.

Larva of May-fly.

May-fly.

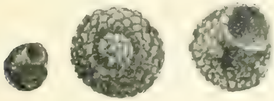
Observe the flight of this insect. Look for the emergence of adults from the larvæ and for the cast-off larval skins.

Under stones in the water several animal forms may be found. The larvæ of May-flies have been mentioned. The larvæ of Stone-flies will also be found. They have two long projections at each end.

Clinging to the stones, however, are some objects which you are likely to overlook. They may be mistaken for small snail shells or mere masses of sand. Collect them and observe them at home. You will find that these apparently inanimate masses move about. In fact each encloses the larva of a Caddis-fly. There are many varieties, which make different kinds of cases of sticks, stones, or leaves. Some are free and some are attached to stones.

A Caddis-worm in its case.

Examine the undersides of stones where the water of the stream flows rapidly. You will find small objects such as stones, clam shells, and even nails, adhering to the surface.



Cases of Caddis-fly Larvæ.

Caddis-fly.

Remove these carefully and you will find that they are attached to each other and to the stone by a sort of network. At one part of the surface of the stone a larger mass of these small objects will be observed. In this will be found a larva of a species of Caddis-fly, an insect related to the Dragon-fly.

IV. THE TRUE BUGS, ETC. (Hemiptera)

A great many trees and house-plants are often infested with plant-lice (Aphides). The males are winged, the females are wingless.

They multiply rapidly during the warm weather, and, in the fall, deposit thick-shelled eggs, which survive the winter. Often in October the winged males become so numerous as

to be a decided annoyance. There are many species infesting various plants.

Ants keep the aphides for the purpose of securing the honey which exudes from the two posterior projections. They have been called the 'milch-cows' of the ants.

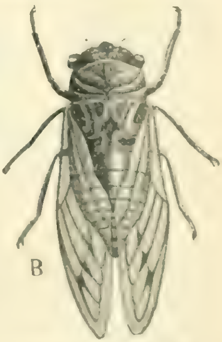
A few years ago, a peach tree was so infested with aphides as to cause the leaves to curl up. Honey bees, in large numbers, were seen to visit the tree, although it was not in bloom. They were evidently gathering honey from the plant-lice.

Plant-lice. (Enlarged.)

Aphides do not eat the leaves but suck the sap, consequently they cannot be killed by spraying with poisonous solutions. Oily solutions, such as whale-oil soap, kerosene emulsion, etc., if sprayed upon them, will close up the breathing pores and thus kill them.

The Cicada. In the hot days of July and August the penetrating crescendo buzz of the Cicadas may be heard in many localities. Their distribution does not seem to be general by any means. The adults live in the trees, where they deposit their eggs. These hatch out and the larvæ drop to the ground. They burrow about the

A Pupa Case of Dog-day Harvest Bug. C Claw of front foot.



Dog-day Harvest Bug.

roots of the tree and live upon the sap which they extract from the tender rootlets.

Different species of Cicada vary in the length of their larval period. Our common species, the Dog-day Harvest Bug, matures in about two years, but there are species which require seventeen years to mature. (17-year Locust.)

At the end of the larval period, the insect crawls out of the ground and ascends a tree, fence, or other support, until it reaches a spot to which it can securely fasten itself. Then, like the Dragon-fly larva, it splits down the back and withdraws itself from the mud-encrusted shell, which it leaves attached to the support. After emerging, the adult climbs a little farther up the tree and rests until the wings expand and are strong enough for flying.

The process described in the last paragraph requires several hours, but, if you are fortunate enough to witness it, the time will be well spent. No verbal description nor series of illustrations can adequately depict it.

Look for the empty larval shells on trees and fences. Note the jerky, zig-zag flight of the adult insect, which makes its capture difficult.

The Cicadas in the larval state do considerable damage to trees.

Squash Bug.

The Squash Bug and the Stink Bug are familiar insects. The former is common wherever its food-plants (pumpkin, squash, etc.), abound.

If you have spent much time about raspberry bushes, you have probably been aware of the presence of the Stink Bug. Its musky odor will not be forgotten, nor its taste, if you have eaten a raspberry perfumed with it.

An insect, which looks somewhat like a Stick Insect

with wings, is the Thread-legged Bug (Emesa longipes).

This insect is a near relative of the so-called Kissing Bug, which attained such notoriety in 1898 in the United States. Comstock calls it 'Assassin Bug.' *Reduvius personatus* is the most widely distributed representative of the Kissing Bugs. It inhabits dirty cellars of houses and feeds on other insects. Its mouth parts form a long tube which it inserts in its victim.

Kissing Bug.

The Giant Water Bug is familiar to most of us, even if its name is not. It often migrates at night, and is found on the ground under electric lights. In 1898 I saw one exhibited on one of the Toronto-Montreal boats, as the genuine Kissing Bug. The Back Swimmers and Water-boatmen are other members of this group which live in water.

The Giant Water Bug.

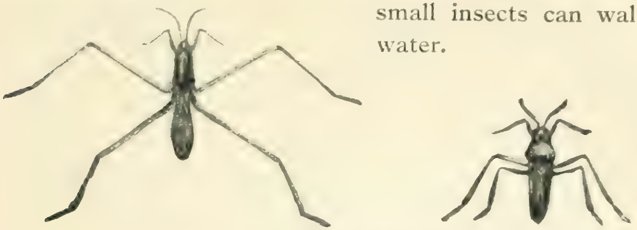
Back Swimmer.

On ponds and quiet pools will be seen long-legged insects that run over the water with the greatest ease. These are the Water Striders. Examine their legs with a microscope to see the fine hairs upon them

Water Boatman.

It seems surprising that these insects can defy ordinary laws, but the surface of water is much more resistant than you think. Lay a *dry, clean* sewing needle very evenly and carefully on the surface

of water and it will float, upheld by the tension of the surface film of water. It is not surprising, therefore, that small insects can walk on water.



The Water Striders.

V. GRASSHOPPERS, ETC. (Orthoptera)

The Grasshoppers, Katydids, and Crickets are the songsters of the insect tribe These with the Cicadas are the only invertebrates which have sound-producing powers worth mentioning. True, their songs are somewhat monotonous, but so are the songs of savages to our cultivated ears. Still the sounds are musical.

The Red-legged Grasshopper is often a destructive pest in grain fields. It deposits its eggs in the ground, in which they hatch, and in which the young develop to a large size. When they emerge they are wingless, but the wings soon develop fully. These young grasshoppers may be found early in the season. Note the comparatively short antennæ (horns), which give this grasshopper and its relatives the name—Short-horned Grasshoppers

The Rocky Mountain Locust (Grasshopper), is the western representative of the Short-horned Grasshoppers "They are hatched out in the plains in countless numbers, eat up everything before them, and consequently become destitute; instinct compels them to move on, just as in the case of the army-worm, and, being winged insects, they fly up into the air to a considerable height, and are then borne along by the

wind, alighting when they reach a country covered with vegetation."

Collect as many grasshoppers as you can, whose antennæ are shorter than the body. Observe their mode of locomotion. How are they adapted for jumping? For flying? How are they protected from observation? Why do they 'spit molasses' when handled? Examine different species to discover how they produce sound by rubbing the legs against the wings. Only males produce sounds.

Hold a grasshopper in the hand and observe its breathing. The abdomen expands and contracts regularly, showing that the breathing organs are situated in this part. Look for the breathing pores (spiracles) along the sides of the thorax (chest) and abdomen. There are ten on each side, two on the thorax and eight on the first eight segments of the abdomen.

The Meadow Grasshopper.

Examine the eyes. Between the two large ones there are three small simple ones called ocelli.

The antennæ are the feelers. With a lens you can see their structure.

Examine the mouth parts to discover how it bites.

The three pairs of legs are attached to the three parts of the thorax. Examine the structure of each pair of legs. With which pair does it jump? How is this pair specially adapted for jumping? Where are the wings attached?

The ear is situated on the first segment of the abdomen, just behind the breathing pore on that segment. It is a sort of crescent-shaped opening, covered with a thin membrane which corresponds to the drum of our ears.

The true grasshoppers have antennæ which are as long as, or longer than, the body. Hence they are called the Long-horned Grasshoppers. The Cone-headed Grasshopper is a familiar species, which makes a piercing 's-zip–s-zip–s-zip' in rapid and continuous succession. Note the pointed head.

The Meadow Grasshopper has a little more variety in its song. It sings 'zip, zip, zip, zip, zee-e-e-e-e-e.'

The Katydids belong to this group. They live and sing in the trees. Whether they say 'Katydid' or 'Katy did'nt' you should decide for yourself by making captives of some of them and listening to their music.

The Katydid.

The Crickets form a third group of singing insects. Everyone has seen and heard the Brown Crickets in garden and in field; yet few of us have observed the way in which the 'cri-cri' is produced by the wings. "The Hearth Cricket of Europe is not common on this continent except in Canada."—*Howard.* It is a yellowish-colored insect.

The Tree Crickets are always heard, but seldom seen. They are *the* musicians of the night. Without them the silence would be felt. They have mostly white or greenish-white wings, and in the daytime may be found on plants,

waiting for the nightfall, when they tune their lyres. Look for them on sunflower plants and low shrubs.

The Hearth Cricket.

The wings are delicately fashioned and veined. Indeed the whole insect is most ethereal in appearance, although it has a very material effect on the grape and raspberry, in the stems of which the female deposits her eggs.

The Ivory-colored Tree Crickets keep up alternate trillings, differing by a tone, which form the background, so to speak,of all the music of the nightly choir.

The Broad-winged Climbing Cricket has a song which is a 'continuous shrill, high-pitched rattle-whistle.'

Note the different sounds which are heard at night, at different seasons of the year. How do the sounds on a warm night compare with those on a cool night? At what time of year do they begin? When do they end? How

The Stick Insect. Where is it?

does rain affect them? How does moonlight affect them? Do they survive hard frosts?

The Stick Insects, or Walking-sticks, belong to the same group as the grasshoppers, etc. They resemble small branches even in details, and are thus protected from their enemies as well as from nature students. As long as they stay on trees they are not likely to be noticed.

VI. THE BEETLES. (Coleoptera)

The Beetles are insects which have the outer pair of wings hardened to form a protection for the body. A common example is the Colorado (Potato) Beetle. The Stag Beetle or Pinching Bug is a frequent visitor in our houses at

Beetle. *Passalus cornutus.*

Burying Beetle.

May Beetle.

night. It is attracted by the light. A black, shiny beetle (*Passalus cornutus*), will be found among decaying wood. The wings are strongly ribbed. The head is provided with three short horns, a pair of stout antennæ, and very formidable jaws.

An interesting species is the Burying Beetle, which buries freshly killed animals, such as squirrels, mice, moles, etc., by excavating the earth underneath the dead animal. The eggs are deposited in the buried carcass, and when the young larvæ hatch out, they feed upon the animal.

The young of beetles pass through a larval stage (*grub*), similar to the larvæ of insects.

In digging up garden soil one is almost sure to turn up white, grub-like larvæ with orange-yellow heads. These are the larvæ of the May Beetle. This beetle lives on the cherry and other trees. The larvæ feed on the roots of plants and thereby kill them.

The Grape-vine Flea Beetle.

The Grape-vine Flea Beetle is a common pest of grape vines, upon the leaves of which the larvæ feed.

The Spotted Pelidnota is common on grape-vines. The larvæ live in decaying wood.

The Plum Curculio is a small beetle which does great damage to plums. At rest, it looks very much like the dried bud of a tree. The beetle deposits its eggs in the blossom just as the fruit is formed, in this respect resembling the Codling Moth. These eggs produce grub-like larvæ which penetrate into the fruit, causing decay and premature falling.

The Spotted Pelidnota
a. Larva. b. Pupa. c. Beetle.

The larvæ form chrysalids in the ground, in which state they usually pass the winter.

The remedy recommended is to collect the beetles early in the morning by jarring (not shaking) the tree, when the

Larva of Plum Curculio. (Enlarged.)

Plum Curculio. (Enlarged.)

beetles will drop and may be caught in sheets spread upon the ground, after which they should be destroyed. Chickens will eat the beetles.

Examine plums which have been stung. Find the larvæ in them and examine them

The wood-borers are mischievous insects, especially the Pine-borer, which destroys pines, etc.,

The Round-headed Apple-tree Borer.

The Maple-tree Borer.

The Pine Borer.

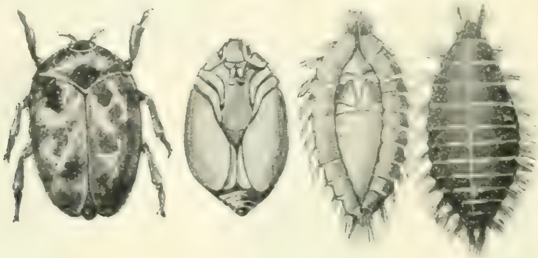
Larva of the Pine Borer.

more particularly after these have been damaged by wind or fire. Note their peculiar antennæ.

The Round-headed and the Flat-headed Apple-tree Borers are common beetles which attack the trunks of apple trees.

The Buffalo Carpet Beetle has become a decided pest in many parts of the country. The larvæ feed upon carpets and other woollen goods, preferring, so the house-wives say, the red colors. The larvæ are hairy, and when full-grown are about half an inch long or less.

The beetle is not more than one-fourth of an inch long, and is very prettily marked with red, black, and white bands or bars. The adult beetles pass the winter in protected places and in May feed upon the blossoms of cherry and



Beetle. Pupa. Larva.
Buffalo Carpet Beetle. (Magnified.)

spiræa. Afterwards they enter houses and deposit their eggs on the carpet. The larvæ which come from the eggs destroy the carpet.

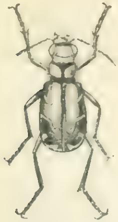
After eating for some time they pass into the pupa stage, from which the beetles emerge later. The empty larval skins may be found along with the active larvæ.

To keep them out of the house, screen all windows and doors in April. The larvæ can be killed with gasoline.

BENEFICIAL BEETLES

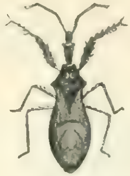
The Burying Beetle has been mentioned as useful in dispos-

ing of dead insects. All the Lady-bird Beetles are beneficial as



A Tiger Beetle.

Lady-bird Beetles.

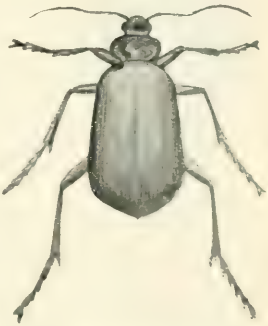


The Soldier Bug.

their larvæ prey upon harmful pests, *e.g.*, potato bugs, and plant-lice.

The Soldier Bug, the Glowing Calosoma, and the murky Ground Beetle also prey upon the Colorado Beetle (Potato Bug.)

The Tiger Beetles are handsome creatures whose larvæ live in holes in dry sandy soil, and feed exclusively on insect prey. Calosoma Scrutator is a beneficial beetle.



Calosoma scrutator.

WATER BEETLES

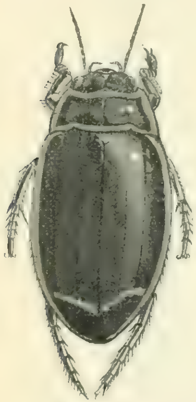
The Whirligig Beetles will attract your attention if you spend much time about water in August and September. Their habit of swimming round and round, in little colonies, apparently for the mere sport of it, gives them their name.

The Predaceous Diving Beetles are common in water. Their larvæ are known as Water Tigers.

These water beetles prey upon the larvæ of injurious insects such as mosquitoes. They are therefore beneficial to man.

They can be kept easily in home-made aquaria, where a thorough study of their habits may be made.

The account of beetles cannot be concluded without a reference to the Spring- or Click-Beetles, the largest of which is known as the Eyed Elater on account of two oval eye-like spots on the upper side of the thorax. When placed on its back, this beetle is able to spring into the air several inches,



A Water Beetle.

The Whirligig Beetle.

A Predaceous Diving Beetle.

A Water Tiger. (Larva of the Predaceous Diving Beetle.)

turn itself over, and alight on its feet. Its larval stage is passed in decaying wood. The larva of one species, which lives in the ground, is commonly known as the Wire-worm, and is often destructive to corn and wheat, the roots of which it attacks. The larval stage extends over two, or, perhaps, three years.

HOW INSECTS BREATHE

Reference has been made to the breathing pores of certain larvæ and to the breathing of the grasshopper. The breathing pores of insects are on the sides of the thorax and abdomen.

Examine the water insects, especially the Giant Water Bug. Two tubes project beyond the hinder end of the body. These are the breathing tubes. The larva of the mosquito

has a tube ending in a rosette of hairs. This tube branches off from the body near the hind end, and supplies the aquatic larva with air.

All these openings and tubes lead into a network of small tubes (tracheæ). The blood circulates through the walls of these tubes and is there aerated. These tracheæ are closely connected, by means of the blood vessels, with the heart, which is situated in the abdomen just above them.

If these openings are stopped the insect will die by suffocation. The surest way, therefore, of killing insect pests which cannot be poisoned with Paris green, etc., is to spray them with oily solutions such as kerosene emulsion, or whale-oil soap solution. If the insect or its larva lives under water, the oil should be poured on the water. It forms a film on the surface of the water which will effectually shut off the air supply.

VII. WASPS, BEES, AND ANTS. (Hymenoptera)

The Wasps, Bees, and Ants belong to a very large order of insects known as Hymenoptera, or membrane-winged insects. They differ from the other orders of insects in two marked respects—in the formation of their mouths, which are composed of two mandibles, and in the fact that they have two pairs of wings.

The study of the Hymenoptera is especially interesting, on account of the highly organized social life of certain of the species, the seeming intelligence which they exhibit, and the peculiar phenomenon of sex-abortion common to the social species. In addition to this, the nature student will find an especially attractive field of study in the examination of the relation of the different families to plant and insect life.

(1) WASPS

The social life of the wasps is less highly developed than

that of the bees and ants. The latter represent later stages in the evolution of the life of the community.

In general appearance the wasp differs from the bee in the form of its body, which is longer, more slender, smoother, and less hairy. The wasp has not yet learned to seek its food to any extent in the flowers, and consequently does not require the hairy legs or the pollen-baskets which the bee has developed for the purpose of carrying its food.

The wasp has two compound eyes. Each eye is composed of several hundred simple eyes or facets. Notice the white line which runs through each eye. Test the wasp's power of sight in various ways. Remove some of the landmarks from the neighborhood of the nest and watch the results. Try the effect of different colored papers placed over the entrance to the nest. Besides the two compound eyes the wasp has three simple eyes, called *ocelli*, in the forehead. These ocelli are sensitive to light, but do not enable the wasp to see.

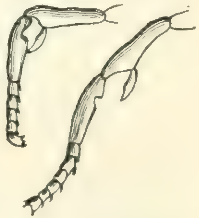
The wasp has two antennæ, or feelers, protruding from the face. Notice the divisions of these antennæ. How many joints are there in each? The small joints at the end of the antennæ are covered with hearing and smelling organs of microscopic size.

With a microscope examine the mouth and tongue of a wasp, and notice the complicated machinery by which the tongue is protected. The tongue of the wasp is short and flat, and is not adapted for extracting the honey from flowers. Make careful note of the kinds of flowers upon which you find wasps feeding. Do you ever see them feeding upon the sweet clover, or the golden rod?

Wasps are omnivorous. They are fond of sweets of all kinds, as well as of insect food and decaying meat. In your walks in early spring, you will observe them feasting on the sap which oozes from the stumps of the trees, where the

wood-choppers have been at work. Every-one has had the unpleasant sensation of finding wasps in the holes in fallen fruit. Do they find their way into your kitchen in preserving time? What attracts them? Upon what insects do the wasps prey? Try whether your captive wasps will touch flies or the cabbage butterfly, or raw meat. The wasp has an unfortunate failing for intoxicants, and if supplied with a beverage of alcohol sweetened with sugar, will return again and again to it, until it becomes helpless.

The body of the wasp is divided into three main divisions, the head, the thorax (or chest), and the abdomen. The six legs of the wasp are attached to the thorax. Examine the legs with a microscope, and count the joints. Notice the cleanliness of the wasp. After eating it uses its front pair of legs to clean its face, going through the operation much after the manner of a cat washing itself. Observe the special device on the joint of the fore leg, the prong and groove, for cleaning the antennæ.



Cleaner of Wasp.

How many wings has the wasp? To what part of the body are they attached? Which wings are the larger? How are the wings fastened together? Does it ever unhook the lower ones from the upper? It is chiefly by the movement of the wings that the humming sound of the wasp is produced.

The sting of the wasp, which serves also as an ovipositor, is situated at the end of the abdomen. It consists of two lances running in a groove and connected with a poison-sac in the body. When the sting pierces the skin of the human body the wasp is generally unable to withdraw it, and is forced to leave it. The wasp does not often survive the shock, and thus literally gives its life for a sting. In deal-

ing with the wasps choose a cold day ; on a hot day they are much more easily excited, and much more likely to sting. If a wasp is left to itself it will not sting, and may even be held in the hand, if care be taken not to frighten it.

On the basis of habit, wasps are divided into two classes, (1) the Social Wasps, and (2) the Solitary Wasps.

(1) **The Social Wasps.** The Social Wasps are divided into two main classes or genera, according as the cells of the nest are enclosed by a paper covering or left unprotected.

The former class, belonging to the genus Vespa, includes two well-known species, the Hornets and the Yellow-jackets. The Hornet may be distinguished from the Yellow-jacket by its larger size, by the white markings on its face and body, and by the fact that it suspends its nest from the branch of a tree or the roof of a building. The Yellow-jacket is black, marked with bright yellow, and its nest is built in a hole in the ground.

In a community of Social Wasps as well as of bees and ants, three classes of individuals are found—the queen, the workers, and the drones. The queen is the mother and founder of the hive, and lays all the eggs from which the others are hatched. The workers are undeveloped females, and it is upon them that the entire care of the hive devolves. The drones are the male wasps.

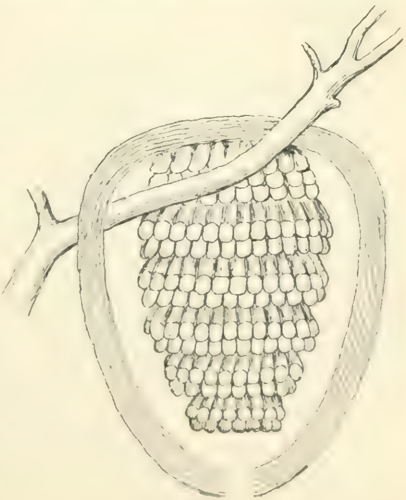
The life of a wasp community is limited to a single season. With the coming on of the cold weather in the autumn, the workers and the drones die off, and only a few of the queens survive, in a torpid state, until spring.

In the spring each surviving queen founds a new community. Having selected a suitable spot she builds a cell of paper, deposits an egg in it and leaves it to hatch out, while she continues to construct new cells in connection with

the first. In the course of time the egg hatches in the form of a grub or larva. After the larva is fed for a time, it spins a cocoon and is then known as a pupa. After a few days it emerges as a full-grown wasp, ready to undertake the duties of the hive. The cell which has been thus vacated is cleaned out and used once more for the same purpose. The first wasps of the season are workers: then the drones are hatched, and lastly the queens appear.

After a circle of nine or a dozen cells has been formed, the wasps proceed to enclose the nest in a paper covering. The paper is made of wood fibres which have been kneaded and cemented in the mouth of the worker. As time goes on, other walls—sometimes a dozen or more—are added to the nest. In the meantime, in the interior of the nest other tiers of cells are added to the first, and the different tiers are extended by the addition of new cells. The structure is enlarged from time to time by tearing down the interior walls of the nest.

In the fall, with the approach of cold weather, the nest is deserted by all the wasps, and even the larvæ are forsaken. The few remaining warm days are spent in feasting.



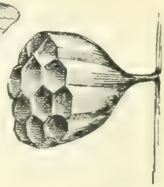
Nest of Wasp.

A wasp's nest may be captured and carried off bodily on any cool evening, when the inhabitants are too much benumbed by the cold to offer serious resistance. It should be

placed in a glass-covered box of such a size that it will fit into the bottom of the window frame. An opening must be made in the box to allow the wasps freedom to come and go with their supplies. The internal economy of a wasp's nest may thus be observed with little inconvenience or danger on the part of the observer.

The wasps of the genus Polistes, the nest of which is not enclosed by paper walls, differ in several respects from the Hornets and Yellow-jackets. In appearance they are brown, with reddish spots and yellow rings, and they are longer

Polistes.



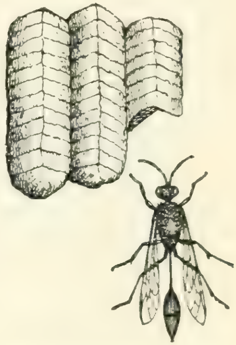
Nest of Polistes.

and more slender in form. The nest of the Polistes is generally attached *horizontally* to a tree or to the wall of a building. The communities in this species are small, and only a few cells are found in each nest.

(2) **The Solitary Wasps.** The Solitary Wasps are divided into three classes—the Masons or Mud-daubers, the Carpenters, and the Miners.

1. The Masons attach their mud nests to the walls of sheds, barns, boat-houses, etc., and sometimes build them on the face of the bank of a lake or stream. In the spring each of the female wasps which has survived the winter, begins to construct a flat, oblong cell, with mud obtained from some puddle in the vicinity. When the cell is finished, the wasp catches a spider, paralyzes it with her sting, and places it in the farther end of the cell. On this spider an

egg is laid, and the cell is then packed as full as possible with spiders. The larva of the wasp thrives best on fresh, living food, and the mother wasp possesses the secret of paralyzing her victims without killing them, so that they remain alive until devoured by the young larva. When the cell is fully provisioned the end is sealed up. In the course of time the egg hatches, and the larva devours the spiders. It then spins a cocoon, and in a few days emerges from its clay tenement a full-grown wasp.



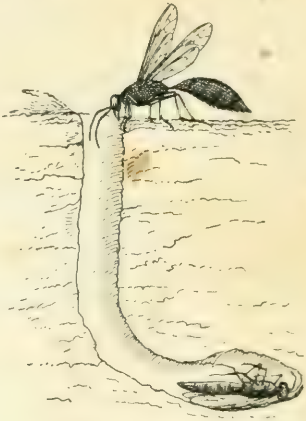
Mud Cells of Mason Wasps.

When the mother wasp has completed one cell it proceeds to construct another side by side with the first. After it has built and provisioned a number of cells it dies, leaving the newly-hatched wasps to construct new nests of their own. In the fall the wasps of the last brood do not lay their eggs, but lie dormant until the spring: the pupæ that are still unhatched when the cold weather comes on, remain in the cocoon stage during the winter, and emerge in the spring. In this way the perpetuation of the species from year to year is ensured.

2. The Miners, or Digger Wasps, resemble the Masons in general habits. But, instead of building a mud cell, the Digger Wasp digs a tunnel some six or eight inches deep in the ground, and provisions it with green grasshoppers, crickets, cicadas, etc. After securing the grasshopper or cicada and paralyzing it, the wasp generally finds that it is unable to fly with so heavy a load. It accordingly drags its burden to the top of a fence post or some other elevation from which it can get a fair start. By repeating this operation at several stages of the journey, it finally manages to

reach its destination. The strength and perseverance of these fragile-looking insects is worthy of admiration. I watched one of them one day removing an acorn which had been pressed some half an inch into the mouth of the tunnel so that it completely blocked the passage. It took half a day's hard work on the part of the wasp, but it finally succeeded in removing the obstruction.

Digger Wasp carrying Cicada.



Tunnel of Digger Wasp.

If you should have an opportunity of observing a colony of Digger Wasps, after due observation, settle the following points for yourselves:—How does the wasp remove the earth from the tunnel? Does it require more than one grasshopper to provision each cell? Does the wasp take its victim directly into the tunnel, or does it go in first to examine the cell? How does it go into the tunnel—head foremost or sting foremost? How does it take its victim in? How does it come out? Does it block up the mouth of the tunnel in its absence? Do the members of a wasp colony ever rob each other, or ever fight?

3. The Carpenter Wasp, or Wood-borer, chooses a small cavity in a tree or log, hollows it out until it is large enough

for a cell, stocks it with insects of various kinds, and finally closes it with a covering of mud. Instead of constructing cells in this manner, certain Wood-borers make use of the hollow stalks of the elder, bramble, sumach, etc., which they partition off into apartments, and provision in the usual way.

(2) BEES

Examine the different parts of the bee, and compare them with those of the wasp already described. Notice especially the hairs on different parts of the body, the pollen-baskets on the hind legs, and the formation of the mouth parts, which are lengthened into a proboscis. What purposes do the hairs, the pollen-baskets, and the proboscis serve in the life of the bee?

Bees, as well as wasps, are divided into two classes, the Social Bees, and the Solitary Bees. Of the Social Bees the two best known species are the common Honey Bee and the Bumble Bee, or Humble Bee.

(1) **The Honey Bee** is an importation from Europe, and is valuable on account of its production of honey. The social life of the Honey Bee is more highly developed than that of the wasp. Only one queen bee, for example, is to be found in a single hive, and without the queen it is impossible for the hive to exist. The conditions under which new queens are produced will form, for the student, an exceedingly interesting subject of study.

The Queen Bee

The food of the bee consists almost entirely of the nectar and the pollen of flowers. The nectar undergoes a change in the stomach of the bee, and honey is produced

and stored away for future use. How does the bee carry home the pollen? What is done with it? Watch a bee gathering nectar and pollen. You will notice that when leaving one flower it goes to another of the same kind. What reason is there for this? Does the bee perform any service for the flowers in return for the pollen and honey which it obtains from them? What color do the bees prefer? To what extent have the flowers adapted themselves to the bees, in form and in color? Have the flowers which the bees visit any perfume? Do the early spring flowers—Anemone, Hepatica, Bloodroot, etc., attract the bees? In the orchard, what fruit trees require the services of the bees? Are the blossoms of these trees fragrant?

Within the hive itself the most interesting process is that of making wax. The following description is quoted from "The Pastoral Bees," by John Burroughs:—

"When wax is to be made, the wax-makers fill themselves with honey and retire into their chamber for private meditation—it is like some solemn religious rite: they take hold of hands, or hook themselves together in long lines that hang in festoons from the top of the hive, and wait for the miracle to transpire. After about twenty-four hours their patience is rewarded; the honey is turned into wax, minute scales of which are secreted from between the rings of the abdomen of each bee; this is taken off, and from it the comb is built up. It is calculated that about twenty-five pounds of honey are used in elaborating one pound of comb, to say nothing of the time that is lost."

The student will find the whole essay on "The Pastoral Bees" exceedingly interesting and instructive.

(2) **The Bumble Bee.** Many species of Bumble Bees or Wild Bees are found in Canada, but the species known as *Bombus fervidus* or *Bombus borealis* is typical of them all.

The Bumble Bee constructs a nest of moss and dried grass a few inches below the surface of the ground. Sometimes the deserted nest of a field-mouse is made use of. The queen bees are the only ones which survive the winter, and in the spring each queen founds a new colony in an underground nest. By securing a nest and placing it in a glass-covered box fitted into the bottom of the window-sash, you may have an opportunity of observing the working of the colony. If you examine a nest in July or August you will find it composed of about twenty cells, or perhaps less. These cells contain larvæ and pupæ in all stages of development. A few of the cells, those which have already been used, will be found to contain honey. The hive itself will be found to consist, in the first place, of the old queen, with perhaps two or three queens newly hatched, a number of drones, easily distinguished by their larger size, and a number of workers of different sizes. The smaller workers perform the duties of nursing the larvæ and caring for the cells: the larger workers look after the external structure of the nest, and supply the food for the hive. Care must be taken in examining a nest, as the workers sting severely. The drones of course have no sting.

Besides the legitimate members of the hive, a Bumble Bee's nest will sometimes be found to contain Cuckoo Bees, or parasites, who lay their eggs in the cells of the Bumble Bees and leave the workers to care for them.

After having made himself familiar with the habits of the Social Bees, the student will find it interesting to study the habits of the Solitary Bees—the Carpenters, the Leaf-cutters, the Masons, the Burrowers, etc.

(3) ANTS

The Ants form a large division of the Hymenoptera; some thousands of species are known to exist. They differ

from the wasps and the bees in the fact that all the species are social and live in communities. In an ordinary ant community five different classes of ants are found, queens, males, large workers, small workers, and soldiers. At certain seasons the queens and males are provided with wings. The eggs of the ant pass through the usual stages in development—from eggs to larvæ, from larvæ to pupæ, and from pupæ to full grown ants. The pupæ are enclosed generally in white silken cocoons. These cocoons are the objects of special care on the part of the workers, who carry them from place to place in the nest to secure favorable conditions of heat, moisture, etc. If the nest is disturbed, the workers at once attempt to carry the cocoons to a place of safety. The life of an ant community is continued from year to year, and differs in this respect from that of a community of wasps and bumble bees.

Ant Hill, eight feet in diameter.

Different species of ants occupy different kinds of nests. Some species live in chambers under ground ; some make galleries in decaying wood ; some build ' hills ' or mounds.

A great variety of substances are used by ants as food. They feed upon decaying flesh, insects, fruit, sap, etc. They are fond of the ' honey-dew,' the secretions from the bodies of the aphides or plant-lice.

It is supposed that ants recognize members of their own hive by the sense of touch, or the sense of smell, located in the antennæ ; and that they find their way to their nests, when away from home, by means of ant paths previously travelled, which they are able to follow also by the sense of smell. It is claimed by some that the ant on no occasion shows evidence of possessing any special intelligence, but that all its actions are merely mechanical. The nature student will find it an interesting matter to investigate this subject for himself.

Besides the Wasps, Bees, and Ants, the order Hymenoptera includes many other classes of insects, such as Gall-flies, Saw-flies, etc., which may possibly come under the notice of the nature student. He should at least make a study of the galls or swellings on the stems of the common plants, Golden-rod, Willow, etc., caused by these insects.

"There be four things which are little upon the earth, but they are exceeding wise :

"The ants are a people not strong, yet they prepare their meat in the summer ;

"The conies are but a feeble folk, yet make they their houses in the rocks ;

"The locusts have no king, yet go they forth all of them by bands ;

"The spider taketh hold with her hands and is in kings' palaces."

—PROVERBS, XXX., 24-28

THE STUDY OF EARTHWORMS

The Earthworms are the commonest members of the branch of animals next below the insects in organization. Many people confuse the larvæ of insects with worms, but a glance will at once distinguish them. The worms have no distinct head, while the larvæ have. The former have no legs, while the larvæ have jointed legs. Although both consist of a series of ring-like divisions, the larvæ have a constant number, while earthworms have a varying number, forty or more.

There are two interesting things about the earthworm. In the first place it is of great benefit to the soil, owing to the fact that it is continually bringing the sub-soil to the surface by passing it through its body. It digests the vegetable matter in the soil and ejects the indigestible portion. Thus the soil is loosened, aired and enriched by the same process. Look for the 'casts' of the earthworm on the bare ground, especially after a wet night.

The other interesting fact is that when an earthworm is cut in two, each part becomes an independent worm, and two worms grow where there was only one before. The story of the hydra-headed monster of the Grecian fable is similar to the story of the earthworm, but the one is a myth, the other a fact which may be experimentally proven. Just how far this division may be carried without killing the earthworm would be interesting to discover.

The advantage of this power of resisting death is evident, inasmuch as the earthworm lives in surface soil, through

which sharp-edged instruments, *e.g.*, hoe, plough-share, etc., often pass.

Its food is vegetable, chiefly leaves, which it drags into its burrow. It accordingly helps to reduce fallen leaves to soil very quickly. Look for leaves in the burrows. How deep does the worm burrow in summer? In winter? Why is it not found in light sandy soil? Where are the largest earthworms found? Why? When do they come out of their burrows? Can they see or hear? Examine the head end for any sign of eyes.

The structure of the animal is very simple and it has few special organs. It has no breathing organs. The blood is aerated through the body-wall. There is no heart, but the whole blood system is contractile. It has no eyes, but is provided with a very rudimentary organ of hearing.

The Hairworms are interesting relatives of the earthworm. They are found in shallow water in ponds and in lakes. Owing to their resemblance to hairs, it is erroneously believed that they are really horse-hairs which have fallen into the water and have somehow become animated. The fact that they become torpid when the water dries up and revive with the return of water, has been accepted as conclusive evidence of their origin from hairs. Needless to say, they have no connection with hairs of any kind, except in appearance.

The Lugworm lives in the sand of the sea-shore, and performs the same work on sand that the earthworm does on soil. Its 'casts' may be seen on the surface of the sand.

The Leech is a worm-like animal often found in pools. It fixes itself to other animals by means of disks, one at each end, and then extracts the blood after cutting through the skin. After one good meal it can live for months without any further food. The medicinal leech comes from Germany. It was formerly highly prized by physicians for the purpose of bleeding patients.

THE STUDY OF STARFISHES
OR ECHINODERMS

The Starfishes are a step lower in the animal scale than the worms. The common Starfish is called 'Five-fingered Jack' by seamen.

The Starfish.

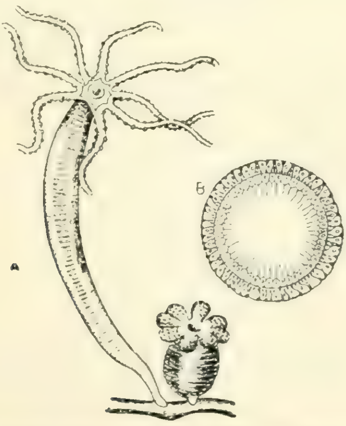
Its most interesting relatives are the Sea Cucumber and the Sea Urchin. All of these are marine forms, but the shells of the Sea Urchin and Starfish are often seen inland as curiosities of animal structure. The Sea Cucumber has no shell. The body has a great many projections which end in disks, by means of which these animals can adhere to and climb up smooth surfaces. The Starfish has these 'tube-feet' on the lower side only; the Sea Urchin and the Sea Cucumber have them arranged in five rows over the surface of their bodies.

The common Starfish, or Five-fingered Jack, is so called because of its five-rayed body. The mouth is on the lower side, in the central portion of the body. The other species mentioned do not show this five-rayed structure externally, but their internal structure is similar to that of the common Starfish. These animals eat oysters and other mollusks.

THE CŒLENTERATES

The Sea Anemone is a still lower form of animal life than the Starfishes. It has the appearance of a plant rather than of an animal. To it are related the Coral Polyps which are improperly called Coral Insects. There is a fresh-water form, Hydra, which may be found adhering to plants in rivers. The mouth of each of these animals is on the upper surface, and is surrounded by numerous tentacles.

"The Hydra is small and appears to the unaided eye as a tiny white or greenish gelatinous particle, attached to some submerged stone, bit of wood, or aquatic plant." When expanded, however, it is easily seen.



Hydra. a In expanded and in contracted condition. b Cross section of the body.

The Hydra is peculiar among animals in its ability to multiply by a process of 'budding.' A new animal grows out from the old one, just as a bud on a tree gives rise to a new branch. The new animal eventually becomes separated from the old one. "Any fragment of an individual hydra is capable of reproducing the rest."

THE STUDY OF PLANTS

To understand the description of flowers it is necessary to make yourself acquainted with certain botanical terms. The outer whorl of leaves of a flower is called the calyx, and its parts sepals ; the colored part is called the corolla, and its parts petals. When there is only one set of floral leaves it is called a calyx, whether green or some other color, and the corolla is then said to be wanting. The whole floral envelope of a lily and its relatives, consisting of two whorls of three leaves each, usually but not always colored alike, is called a perianth.

Inside of the corolla are usually situated yellow-knobbed bodies, the stamens, which together make up the andrœcium. The centre of the flower is occupied by the pistil, (gynœcium) the parts of which are called carpels.

The calyx protects the flower in the bud. The corolla attracts insects. The stamens produce the yellow pollen dust in the little knobs (anthers) at the ends. In order to produce seed the pollen dust must reach the pistil, which is specially prepared to receive it, the end of the pistil (stigma) always being sticky. The stigma is usually borne on a stalk (style) which is simply a prolongation of the main part of the pistil, the ovary. In the ovary the seeds are developed from the union of the pollen grains with the germ cells of the ovary.

In most plants seed is formed only when the germ cells are fertilized by pollen from another flower of the same species. In any case better seeds are produced by cross-fertilization than by self-fertilization. Hence there is usually

some arrangement by which the pollen of a flower is prevented from reaching the stigma of the same flower. If it does reach the stigma, it is inactive. Some plants are cross-fertilized by wind, *e. g.*, willows, grasses; some by water, *e.g.*, Eel-grass, Potamogeton; but nearly all by insects, particularly flying insects, such as bees, butterflies, moths, and wasps. In fact, many flowers can be fertilized by only one species of insect, and are so constructed as to refuse all advances from any other insects. In some cases the flower-tube is so long as to be fathomed only by the long tongues of the butterflies and moths; some flowers open at night to welcome the moths; some are closed except to the bees; some droop so as to be inapproachable by any but flying insects; some entrap undesirable insects.

Flowers, therefore, must be studied in relation to insect visitors, and these should be observed before the flowers are gathered. There is not only a relation between the structure of the flower and its insect visitors, but the flower opens about the time that the insects which cross-fertilize it appear.

Flowers which bear stamens but have no pistil are called staminate, while those which have a pistil but do not bear stamens are called pistillate. These two kinds of flowers may grow on the same plant (squash), or on different plants (willow). Most flowers have both stamens and pistil.

The love of flowers is, perhaps, our most common characteristic. Too often this love is centred on the cultivated varieties, to the exclusion of native trees and flowers. There is a charm in the natural simplicity of our field and wood flowers, quite lacking in the overfed prodigies of the garden and the greenhouse.

As soon as the snow has vanished, or even while drifts are still lying in the hollows of shaded hillsides, you should begin to visit the woods. The ground is still carpeted with last

season's cast-off garments, and the branches of the forest monarchs wave appealingly to the gentle south breeze for the warm, moist air which will clothe them again in varied robes of green, and carpet those ancient aisles with flower and fern.

But all is not dead. Something in the air is life-like, pulsating, entirely different from the hazy stillness of October days; and sure enough, there pushing its way through the leaves, are the blossoms of Hepatica, surrounded by the new, half-opened, crumpled leaves, and by the toughened survivors of the previous year.

The flowers of Hepatica vary in color from bluish-white to blue or purple. The hairy flower-stem springs from the ground and bears six to twelve sepals. Just below the sepals are three hairy, leaf-like bracts, which are almost sure to be taken for a part of the flower, but there is a small portion of stem between these and the flower.

There are two species of Hepatica, the sharp-lobed (3 to 5-lobed leaf), and the round-lobed (3-lobed leaf). Note that all parts of the flower are separate from each other.

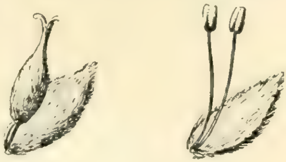
About the same time or later the marsh-lands are spattered with the yellow flowers of Marsh Marigold, a plant belonging to the same family as Hepatica. The Skunk Cabbage, too, has already sent up its huge leaf, enfolding the club-like mass of flowers, and now lures the black flies with its malodorous scent. The latter plant is often found growing up through the ice in March.

Even if you do not visit the woods thus early, the pussy-willows will announce the coming of spring by bursting through their winter coats. Indeed, they have been peeping through the rents all winter.

Some of the willows bear silvery tassels (catkins), while others bear golden ones. The color indicates a difference

1. Pitcher Plant. *Sarracenia purpurea.*
2. Purple Violet. *Viola cucullata.*
3. Yellow Lady's Slipper. *Cypripedium parviflorum.*
4. Wild Columbine. *Aquilegia Canadensis.*
5. Purple Flowering Raspberry. *Rubus odoratus.*
6. Marsh Marigold. *Caltha palustris.*

in structure. Examine a single floret from each. Each floret is but half a flower, growing in the axil of a leaf-like bract. A is a pistillate flower, and B is a staminate flower, while neither has calyx nor corolla.



A. Pistillate. B. Staminate.
Flowers of Willow.

Many trees bear flowers similar to those described above, *e.g.*, poplars and sycamores. Most of our native trees have inconspicuous flowers which appear before the foliage and are usually entirely overlooked.

There is a plant which flowers very early in the season (March-May), whose flower is scarcely ever found except by one who knows its hiding place, or who makes a close examination of every form of plant-life which he meets. Its leaf is prominent throughout the season, especially in northern woods, and attracts the eye not only by its size but by the prominent veining, which forms a distinct pattern on the leaf. Each plant bears two leaves.

The flower is usually under the dead leaves of the woods, or even buried in the mould. It is a three-cleft cup, green outside, and purple within. It is cross-fertilized by flies or perhaps by crawling insects which at this early season of the year seek shelter from the cold in the deep cup.

All parts of the plant have a gingery taste, hence it is called Wild Ginger.

Dog's-tooth Violet will soon be met with among the windrows of leaves. It is a Lily in reality, but has ignored its family name. Its six petals, in two whorls, are pale yellow or occasionally creamy white. Inside the corolla, note the six stamens arranged around the central, three-lobed pistil. The drooping aspect of the flower is adopted by it for the express purpose of being 'not at home' to ants and

such-like crawling trash, for the Lily belongs to the aristocracy of plants, who are 'at home' only to flying creatures. The two leaves are rather thick and are characteristically blotched. Dig deep to find the bulb from which each plant springs.

Bloodroot.
Sanguinaria Canadensis.

Dog's-tooth Violet.
Erythronium Americanum.

The next acquaintance made will be with the pure white blossoms of Bloodroot, whose war-paint is hidden beneath the ground. Do not fail to unearth the underground part of all these flowers of early spring, for the reason of their early flowering is found there. Bloodroot has a storehouse of rich food laid up in that repulsive, underground stem (root-stock), reserved from last year's supply for this very day's growth. Note how the leaf enfolds and protects the flower while it is young and tender.

There is a two-parted calyx belonging to this flower, but it falls as soon as the flower opens and leaves the eight to twelve petals alone. The garden Poppy is a relative of Bloodroot.

Wind-flower. *Anemone nemorosa.*

Writing of 'the melancholy days' Bryant mournfully says,

"The Wind-flower and the Violet they perished long ago."

The Wind-flower (Anemone) is a relative of Hepatica and loves the dry hillsides of open woods. It is a dainty flower;

"And where a tear has dropped, a Wind-flower blows."

It has no whorl of green leaves outside the white flower, so we, in common with botanists, call the white floral leaves a calyx, and its parts sepals, and say that the corolla is wanting. Compare this flower with Hepatica and Marsh Marigold. They all belong to the same family (Crowfoot).

The common western species is the Prairie Anemone, a

plant which is covered with silky hairs. The fruit has long, feathery tails.

Most of us go to the woods in spring and return laden with what we call May-flowers and Lilies. The so-called May-flower is the Spring Beauty. It is related to the common Purslane, the bane of the gardener, but it has a much better social standing than that despised weed. Note the two-parted calyx and the dark-veined, rose-colored petals of the corolla.

Trailing Arbutus—Mayflower.
Epigæa repens.

Spring Beauty.
Claytonia Virginica.

The real May-flower of Canada is the Trailing Arbutus. It is much less common than the Spring Beauty, preferring the cooler parts of the woods and flowering earlier in the season.

Every one is familiar with the Trilliums (Lilies), of which there are several species. Collect different species and compare their flowers and leaves. Whenever a plant pulls from the ground as the Trilliums do, with a long, clean, bleached portion ending abruptly in a clean break, you may know there is a bulb, corm, or rootstock below, and you should unearth it. The roots spring from it.

Compare Trillium with Dog's-tooth Violet. The flowers are alike in many respects but the leaves differ. The latter has typical lily leaves, straight-veined.

The May-apple is so well-known as to need no description. Its leaves and roots are poisonous if eaten.

The Star-flower is a plant with simple whorled leaves (7-9) and a delicate white flower, with a usually seven-parted calyx

Star-flower. *Trientalis Americana.*

Naked-stalked Mitrewort.
Mitella nuda.
M. diphylla has two leaves on the flower stem.

False Mitrewort - Foam-flower.
Tiarella cordifolia.

and corolla, but the number of parts varies from five to nine. It is found in moist woods in May and June.

About the same time the Foam-flower blooms. It has the name False Mitre-

Wintergreen. *Gaultheria procumbens.*

wort, the true Mitrewort being usually found near by. The beauty of the Mitrewort is in its feathery petals, which form a star-shaped, five-rayed snowflake of a flower, quite different from the flower of the False Mitrewort.

The bright red berries of the Wintergreen may be found in the woods in spring, the combination of bright red and dark green being very pretty. The flowers do not appear till June or July.

We all recognize Violets, but we might learn a great deal more about them by collecting and comparing the species which flower at different seasons. There are twenty species of Violets in Canada. (See Spotton's *High School Botany.*)

The Bird's-foot Violet has a leaf suggestive of a bird's foot, hence its name. It has a large purple flower about one inch across. It is found in the North-West.

Bird's-foot Violet. *Viola pedata.*

Nearly all the Violets have hairs in the tube of the corolla, and one of the petals is spurred. The hairs are a barrier to small, crawling insects, while the spur, which contains the nectar, is accessible only to the bee, by whom the pollen is carried from flower to flower. The drooping habit, so characteristic of the Violet, prevents water from filling the flower cup.

There are several species of the Lily family which flower in June. Their leaves, unlike those of the Trilliums, which are net-veined, are straight-veined, as the leaves of all real Lilies should be. Some of these Lilies have four-parted corollas, which, for a Lily, is as disgraceful as having net-veined leaves, hence these are called False Solomon's Seals. Others have six-parted corollas, as true Lilies should have, and are called True Solomon's Seals.

Wild Lily-of-the-Valley. *Smilacina bifolia.*

False Spikenard. *Smilacina racemosa.*

The largest of the first group is False Spikenard. The stem is leafy and slightly zig-zag, while the flowers are in

clusters at the end of the stem. There is also a three-leaved species and a two-leaved species of this group of plants. The latter is called the Wild Lily-of-the-Valley. Often the visible part of the plant consists of a single leaf which never bears a flower.

The True Solomon's Seal also has a leafy stem, but its drooping flowers are arranged in pairs along the underside of the stem. All these Lilies spring from fleshy,

Smilacina stellata.

True Solomon's Seal.
Polygonatum biflorum.

underground stems (rootstocks), upon which are markings something like a seal, but whether like Solomon's or not I cannot say.

The Onion, Leek, and Garlic belong to the Lily family. The Leek is peculiar in flowering after the leaves have quite withered away, in this respect resembling Witch Hazel, a late flowering shrub.

Linnæus was the father of botany, yet few plants bear his name. One, however, was selected by one of his disciples, Dr. Gronovius, as a monument of the man of flowers. This plant is the Twin-flower, whose pink flowers grow in nodding pairs in damp, mossy woods, where they may be found in May and June. In order to commemorate the founder of botany you should learn the scientific name of this plant, *Linnæa borealis.* The specific name suggests a northern habitat, which it much prefers. Indeed, it has been found by J. W. Tyrrell, in the Barren Lands, 62° N. Lat.

No one can fail to recognize its delicate pairs of nodding pink flowers. The leaves are opposite, rounded and evergreen.

Jack-in-the-Pulpit needs no introduction. We are all attendants in his church, yet he is all the time preaching to some who, "having ears, hear not." How many of us have heard him tell us that there are two sizes of this plant; that the smaller ones do not bear fruit; that the larger ones do? How many have heard him tell how insects are lured to the smaller variety, imprisoned until properly dusted with pollen, then released, only to be made captive in the larger variety where death ends their misery? How is this done? He will tell you if you listen. How does this plant survive the winter? The answer can be learned by giving close attention to what Jack has to say.

The part on which the flowers grow is called the spadix; the leaf enfolding it is the spathe. Examine these thoroughly at different times of the year. The large underground part of the stem is a corm. It has a very acrid taste. In the fall look for the red masses of fruit, each with the withered spathe about it.

In bogs, especially in peat bogs, the striking and unique Pitcher Plant will be found with its hollow leaves filled with

water in which insects are drowned, decomposed, and thus prepared as food for the plant. (See plate.)

It is the leaf which gives the name to this plant. Although it is not quite like a pitcher, still it holds water and has a lip-like mouth. To make sure that insects, which crawl in, can not get out again, the inside of the lip is provided with downward-pointing hairs, which make the way down easy as the proverbial paths of sin, but effectually bar the return of the repentant insect. Each flower rises on a naked stalk from the centre of a group of these leaves.

Leaf of Pitcher Plant.

Round-leaved Sundew. *Drosera rotundifolia.*

Another plant which has carnivorous habits is the Sundew. It, also, is found in peat bogs. In fact, these plants, living as they do in these bogs, are compelled to resort to animal food, because the soil in peat bogs does not contain any nitrogenous food.

The leaves of the Sundew are like little round-bowled spoons, the bowls of which are covered with glands. At the end of each gland is a sticky excretion, which glitters in the sunlight like a drop of dew. Insects are held by this excretion, and the glands gradually close down upon them, holding them until they are digested, when the glands resume an erect position.

The Blue Flag is so common as a cultivated garden flower that one is apt to be surprised to see, as one may see around Georgian Bay, acres of low, wet land covered with these flowers. The delicately-veined, purple petals, three large and three small, make a very handsome flower, while any suggestion of stiffness is avoided by the three-parted style being leaf-like and colored to harmonize with the rest of the flower. The way in which the bee cross-fertilizes this flower is very interesting.

While lily-like in structure, it belongs to another family (Iris), distinguished from the Lily family, by having the base of the petals grown fast to the pistil.

Blue-eyed Grass is another member of this family. The six-parted flower is symmetrical and very pretty, but closes up almost immediately after being picked. (See plate.)

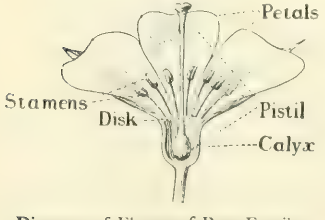


Diagram of Flower of Rose Family.

The Rose family of plants is a large and valuable family, to which belong the Rose, Apple, Raspberry, Strawberry, Cherry, Pear, etc. If you examine an apple blossom you can discover the distinguishing characteristics of the family, which are as follows: *There are five petals and numerous stamens. These are situated on a sort of thickening of the calyx-tube called a disk.*

The family contains a great many wayside plants in addition to those of the garden mentioned above. Two of these will be found in almost any part of the country. One is known as Silver-weed because of the whitish appearance of the underside of the compound leaves, which have nine to nineteen leaflets.

The plant gives off runners, upon which the yellow flowers are situated. These runners give the plant the appearance of the strawberry, to which, of course, it is related. It prefers sandy soil, especially the shores of our lakes, and is common westward.

The other plant is the Norway Cinquefoil. The stem is erect, hairy, and branching above. The flower is yellow. This plant is more widely distributed than the former, but grows singly instead of in patches. The leaves are composed of three leaflets.

Norway Cinquefoil. *Potentilla Norwegica.*

The hairs of plants are of benefit in two ways at least. They enable it to shed water easily, and they also prevent small, injurious insects from crawling up to the flower to rob it of its nectar.

The Wild Columbine (see plate) is in flower about the first of June. Both sepals and petals are colored but the petals are spurred. These spurs give the flower a handsome appearance, and make its relationship to Buttercup and other flowers obscure. It is, however, a member of the Crowfoot family.

The spurs contain the nectar, and the length of the spur makes it impossible for any insect, except the bee, to reach this nectar. You should observe bees, butterflies, wasps, etc., while they are gathering honey. The peculiar shapes of flowers are always for some purpose, and usually have a direct relation to the structure of their insect visitors, who pay for the honey they get by carrying pollen-dust from flower to flower to cross-fertilize them.

This plant extends from the Atlantic to the Rocky Mountains. Its color varies considerably in different parts of the country.

One cannot soon, if ever, forget the emotion on finding the Yellow Lady's Slipper (see plate), or its relative, the Pink Lady's Slipper, in the woods for the first time. There are woods around Georgian Bay in which, about the middle of June, one may find these beautiful Orchids; and a little deeper in the woods, across a narrow pond, formed by a hollow between ancient, shore sand-dunes, the green and purple Pitcher Plant. These three plants, with a white Fringed Orchid found in this same pond, and Orange-red Lilies found in the wood, made the most magnificent combination of wild flowers the writer has ever seen, and all were so abundant that they were carried away in armfuls. Three staid and sober men became so excited over their 'find' as to fall into the pond and wade knee-deep (though seven miles from home) to gather the beautiful flowers from its margin of peat moss.

The Lady's Slippers will repay the closest examination, for they are beautifully and wonderfully made, and especially adapted, as all Orchids are, to cross-fertilization by insects. The common Milkweed is, however, quite as remarkable in this respect.

In June, too, we find the evergreen Pyrola. One variety

1. St. John's Wort. *Hypericum perforatum.*
2. Fireweed or Great Willow Herb. *Epilobium angustifolium.*
3. Blue-eyed Grass. *Sisyrinchium angustifolium.*
4. Self-heal. *Brunella vulgaris.*
5. Jewel-weed or Spotted Touch-me-Not. *Impatiens fulva.*
6. Blue-weed or Viper's Bugloss. *Echium vulgare.*
7. Yellow Evening Primrose. *Œnothera biennis.*
8. Blue Vervain. *Verbena hastata.*
9. Buttercup. *Ranunculus acris.*

has greenish-white flowers, another pale pink, another rose-purple, but the general appearance is the same in all. The flowers are arranged in a loose, somewhat one-sided cluster, on a naked stalk six or eight inches high. The leaves vary in shape in different species.

The common yellow Wood Sorrel is found almost everywhere from May to October. It has a three-parted compound leaf, smaller, but much like a clover leaf. The leaves fold up very characteristically under certain conditions.

Wherever shallow water is, there will be found the Arrowhead and some of its relatives. It is a study in symmetrical tri-partite arrangement. The leaves are three-pointed, the stems three-angled, the flowers three-parted and in groups of three upon the stem. There are several varieties varying in form of leaf and size of flower, but in all, the pure white flowers with yellow centres are beautiful in their simplicity.

The Yellow Evening Primrose (see plate), which unfolds its flower in damp weather and at night, is widely distributed in sandy soil. There is design in this habit of opening at night, for the flowers are cross-fertilized by moths, which fly only at night, and the length of the flower-tube corresponds to the length of the moth's tongue.

Note that this is a symmetrically four-parted flower. Look for undeveloped flowers in which insect larvæ are to be found.

A cultivated variety, Love Pops, can be seen to unfold about sundown.

Fireweed, or Great Willow Herb (see plate), found on ground which has been newly cleared and fire-swept, is a member of the same family of plants. It ranges far north. The stamens develop before the pistil. Examine its seed-pods and seeds.

The Geranium, so common in our homes and gardens, is,

no doubt, the cultivated species of the Wild Geranium, which unfolds its pink or light purple flowers in June.

Bunch-berry is a common wood flower of June. It appears to be a white flower with four petals, but it is in reality a head of small flowers, of which four of the outer ones are especially developed, doubtless for the purpose of attracting insects. It ranges far to the north.

Shepherd's Purse.
Capsella bursa-pastoris.

Examine the Candytuft of the garden, in flower and in fruit; then look for its field relative, the Shepherd's Purse, which flowers all summer and fall, even after snow falls in December. The fruit is inverted heart-shape.

Partridge-berry. *Mitchella repens.*

The dainty, paired blossoms of the Partridge-berry appear in June, but the fruit, a red two-eyed berry, may be found in spring as soon as the snow has melted away.

A common lilac-colored or bluish flower, found in the woods in May and June, is Phlox. The flower has a long tube with five spreading petals.

A flower of the meadow and roadside, which blooms from June to October, is the Buttercup (see plate). This is a rela-

tive of Marsh Marigold, which often gets the name Buttercup. The petals of the Buttercup are waxy yellow, and all the parts of the flower are separate from each other, as in all the members of this family (Crowfoot). They are all more or less poisonous and should not be tasted. The western representative is the Dwarf Buttercup, only eight inches high.

Study the mode of flowering to discover how this plant continues to flower all summer.

St. John's Wort and the Purple Flowering Raspberry (see plate) are common flowers in June and July. The former has a yellow flower, the latter a dark red one. The former is a wayside plant, preferring sandy soil, while the latter seeks the margins of woods and the gully sides.

Black-eyed Susan or Cone-flower is a well-known flower of July in meadows and in open sunny places. In August it makes the Manitoba prairie 'one blaze of yellow.' It is a good type of the Composite family of plants, to which so many of our plants belong. The ray-flowers are yellow, the disk-flowers a deep purple, arranged in a cone-shaped mass. Examine picked specimens of this flower to discover the relative development of stamens and pistils.

Blue Vervain (see plate) is common on low grounds, and will be found in bloom from July to September. It grows to a height of three to five feet.

Clematis or Virgin's Bower is in evidence, both in flower and in fruit. It is a vine which runs riot over wayside fences, along streams, and in swamps. In July its clusters of white flowers brighten the landscape, while, in the fall, the hoary fruit attracts the eye from afar. The leaf resembles that of Poison Ivy, but has a quite different venation (see plate).

All Clematis vines do not bear fruit, because the staminate

and pistillate flowers are borne on different plants. Only the latter bear fruit. Clematis is a member of the Crowfoot family.

The Thorn Apple is a coarse, ill-scented weed, sure to be found by wayside rubbish piles and often in cultivated ground. The long, funnel-shaped corolla opens at night to welcome the Tomato Sphinx Moth, whose long tongue is particularly well adapted to reach the nectar at the bottom of the flower. In the Essex tobacco fields, rows of these plants have often been placed among the tobacco plants, poison being put in the flowers to kill the Tobacco Moths. I understand, however, that spraying the tobacco plants to kill the larvæ is now generally practised.

Spreading Dogbane.
Apocynum androsæmifolium.

The Spreading Dogbane is a shrubby plant two or three feet high. The pink-white flowers grow in drooping clusters, and each flower is provided with a trap-like structure which catches insects. The larger ones, butterflies and bees, can pull their tongues out of the trap, but small flies and ants are often held until starved to death.

This plant has a milky juice, like Milkweed. It grows along roads and borders of thickets.

The Milkweed is so well-known as to need no description. The flower is the most complicated structure of the

flower-world, not excepting even the Orchids. The calyx and corolla are bent back, and the centre of the flower is a five-sided, flat-topped stalk, around which are five hooded nectaries, encircling the five stamens. Between each two stamens is a slit, into which the legs of insects enter when they are gathering nectar. The leg comes in contact with a saddle-like connection joining two masses of pollen (pollinia). On this uniting band is a notch in which the insect's leg catches and then withdraws the pollinia, and carries them to other flowers, as the insect visits them.

The large seed pod, with its numerous flat, brown seeds provided with down, is an interesting study in seed distribution. Why is the pod so peculiarly attached to the stem?

The milky juice entangles the feet of small insects, such as ants which attempt to climb up it.

Harebell. *Campanula rotundifolia.* Leaves at the base are round.

The Harebell is known in verse and story. The large blue bells (corollas) are conspicuous because of the narrow leaves of the plant. It blooms in July and August. It is one of our most beautiful prairie flowers.

Self-heal seeks to escape detection by keeping close to mother earth, especially in lawns. In moist soil it may reach a height of eight or ten inches. It is a relative of Catnip, Mint, etc. (Mint family). Note the square stem, opposite leaves, two-lipped corolla, and four-lobed pistil—the characteristics of this family (see plate).

Jewel-weed, or Spotted Touch-me-Not, is found in moist, shady spots. The peculiarly shaped flower, with its curved projection, is well shown in

the plate. It resembles the Nasturtium of our gardens. The fruit is a pod, which bursts when handled, and thus scatters the seeds in all directions.

Toad Flax, or Butter-and-Eggs, is also well shown in the plate. (See Part II., Methods.)

Cardinal Flower presents such a spike of brilliant red flowers that we know it at sight, if we have but heard of it. The corolla, like all Lobelias, is split down on one side for the convenience of bees, who visit it for the nectar. This plant is common in August along railways and in damp woods. It has a blue relative which flowers in October.

The name Chicory is familiar from its association with coffee, but we are not all familiar with the pretty blue flower of that name (see plate). It is another of those wide-spread Composites although it is easily mistaken for a simple flower. Sometimes it is almost white.

Bur Marigold attracts our attention in the fall, when its pitchfork burs (fruit) stick so persistently to our clothing, whether we notice its rather pretty yellow-rayed flower earlier in the season or not. There are five species in Canada. They also belong to the Composite family.

Bouncing Bet (see plate) has not yet been free from cultivation long enough in this country to return to its native simplicity, but still forms double flowers. It is interesting as a type of the Pink family which includes the Catchfly, Corn Cockle, Chickweed, and our beautiful Carnation. It flowers from June to September. Note the opposite leaves and swollen stem-joints which characterize this family of plants.

Asters and Golden-rod are so well known as to need no introduction, but there are many more species than we think —over twenty of each. The purple and white of the Asters and the yellow of the Golden-rod (one species is almost white) are characteristic of our autumn landscape. Even

1. Fringed Gentian. *Gentiana crinita.*
2. Bouncing Bet or Soapwort. *Saponaria officinalis.*
3. Toadflax or Butter-and-Eggs. *Linaria vulgaris.*
4. Chicory. *Cichorium Intybus.*
5. Closed or Bottle Gentian. *Gentiana Andrewsii.*
6. Aster. *Aster Novae Angliae.*

after the frost has touched all vegetation, there is still a beautiful color effect where these plants cover the low-lying ground. They are Composites, that is, the flowers are in heads, surrounded by one or more circles of leaves (involucre). (See plate.)

Nature has reserved some of her most beautiful flowers for autumn days. The Gentians flower in October or even later, in November. The Closed Gentian is a particularly hardy plant, ranging far to the north, and the Fringed Gentian is common on the western prairies (see plate).

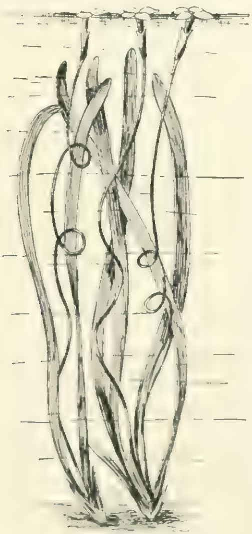
Why does the Closed Gentian not open its petals to the sun as other flowers do? It is closed to keep out small insects, but will admit the bumble bee, who is strong enough to force the petals apart. But why are flowers so partial to the bumble bee? It is because the bumble bee is the best insect-agent in cross-fertilization. It never mixes drinks, while ants and other insects do. The bumble bee goes from one flower to another of the same species, but ants climb whatever comes in their path. Hence flowers have learned to guard their riches from any but those who give an equivalent for them in the way of transporting pollen-dust.

The most surprising flower of the season is the Witch Hazel, and a witch it surely is. I well remember how its yellow flowers with strap-like petals, borne on leafless branches, surprised and confounded me when brought into the class-room on a November day, long after we had ceased to look for flowers.

The Witch Hazel is a shrub, ten or twelve feet high. It grows in thickets, on hillsides, near streams. One year's fruit remains on the tree throughout the following season, evidently needing the cold winter weather to give it a start on its road to maturity, though no growth takes place till spring. Its leaves appear in spring as those of ordinary

trees. When the fruit has matured in late fall the pods burst, and by their peculiar structure press the seeds out with

Witch Hazel. 1 Flower. 2 Leaf. 3 Branch showing flowers and fruit. 4 Fruit.



Eel-grass.

such force as to throw them several feet. It is interesting to carry a branch into a warm room in October and witness this phenomenon. Examine the pod and explain how the seeds are forced out.

As an example of striking adaptation to environment, the Eel-grass of ponds and sluggish waters is interesting. The illustration shows the coiled flower-stalks, which can easily adapt themselves to the rise and fall of the water and also move about. This is but half the wonder. The flowers which produce stamens grow at the bottom of the water, and when mature, break off and rise

to the surface, where the pollen escapes and fertilizes the flowers floating there. After fertilization the coiled flower-stalk contracts, drawing the flower under water, where the fruit matures in ideal conditions.

When flowering plants are becoming fewer, we are more interested in the common ones hitherto neglected. Though Shepherd's Purse, Yarrow, Charlock, Mustard, and Sweet White Clover have been flowering all summer, we are interested about the end of October to find these still surviving the hard frosts. An occasional Aster and Golden-rod may still be found in bloom, a dash of color here and there amid the sea of whitened heads of fruits of the earlier flowering plants. The hoary plumes of Virgin's Bower increase the general grayness of the landscape. But beyond and behind there is still a glorious background of the green of the pines, the russet brown of the oaks, and the yellows and reds of the maples, not yet entirely bereft of their summer foliage. The yellow button-like heads of Tansy may still be found among the crowded patches of this social plant.

DECEMBER FLOWERS

December 14th, 1901.—The fall has been a long and comparatively cold one, with a particularly cold week in early December—almost zero weather with a few inches of snow. Yet to-day, when rain has melted away the snow, I find three

Fruit. Corn Speedwell.

flowers still blooming beneath it, Shepherd's Purse, Corn Speedwell, and Chickweed. The first has been mentioned already. Corn Speedwell has a delicate blue flower and a flat-

Chickweed.

tened heart-shaped fruit. This plant lies close to the ground as Chickweed does, and thus in its humility finds safety.

OBJECTIONABLE PLANTS

There are black sheep in every flock, and there are plants whose bad qualities so outnumber their good ones, that we consider them harmful and call them 'weeds.' To some people nearly all wild flowers are weeds, but these people do not see them as parts of one great universe, but as dead matter fit only to be burned or consigned to the rubbish pile.

Most of our harmful plants have been introduced from Europe where they learned, by long experience, the most expert methods of propagating and distributing themselves. Finding here large areas of waste land, they have spread rapidly in the land of their adoption. As waste areas are brought under thorough cultivation these noxious weeds will be forced to the wall.

Some of these plants are known 'by their fruits' which are provided with hooked projections, forming what we call burs. Such are Bur Marigold, Burdock, Cocklebur, Hound's Tongue, Beggar's Ticks (see under "Plant Tramps").

Sheep Sorrel is a weed which grows in sandy or poor soil. The flowers, which are in close terminal clusters, have a greenish appearance, turning reddish in fruit. It flowers from June to September. An average plant produces about ten thousand seeds.

Sour Dock is a member of the same family, but is a stouter plant, the root especially being very large.

Thorough cultivation and enrichment of the soil will eradicate both of these pests.

The Ox-eye Daisy, so familiar to all who gather Daisies in meadows, is really a most pernicious weed. The admiration which so many have for its white-rayed flower, with yellow disk, aids in spreading it broadcast through the country. In many cases it is seriously injuring the hay-crop, and, though it does not trouble the farmer in cultivated soil, it should be destroyed.

'Pusley' (Purslane) is the worst plant-foe of the gardener. Its spreading habit, its ability to grow in any soil, wet or dry, and to propagate itself from small cuttings, make it almost invulnerable. Stem and leaves are thick and

Sheep Sorrel. *Rumex acetosella.*

fleshy, and the flower is of a delicate yellow color. An average plant produces sixty thousand seeds. In combating this plant care should be taken to remove it, entire, from the soil.

Portulaca is a pretty relative of this weed, which is often seen in gardens as an ornamental flower,

Purslane, with roots springing from cut end.

varying from many shades of red to yellow and orange. It does not become a noxious weed. Observe the flowers of these plants on damp days.

Catchfly. *Silene noctiflora.*

The Catchfly is found in waste grounds. There are two or three species, but the one shown in the illustration is interesting because its stem is hairy and quite sticky, and because the flower opens only in cloudy weather or at night. No doubt the stickiness is to baffle the ants and other crawling insects, while it opens chiefly at night in order to


SUGAR
(HARD)
MAPLE
SMALL RED
MULBERRY LEAF
RED MULBERRY
POISON
IVY
CATALPA
SYCAMORE
(BUTTON WOOD)
SILVER
(SOFT)
MAPLE
VIRGIN'S BOWER CLEMATIS

save its nectar for night-flying moths which cross-fertilize it. Note the opposite leaves and swollen joints of the stems which show its relation to Carnations, Corn Cockle, Chickweed, Bouncing Bet, etc.

We should know Poison Ivy in order to avoid contact with it ourselves, and to warn others from touching it, for, to certain people, it is a most virulent skin-poison. Some are so susceptible to poisoning by it as to be poisoned by wind which has passed over it.

Fruit of Poison Ivy.

It can be best recognized by its three-compound leaf (see plate) and greenish white cluster of flowers, growing well under the shadow of the leaves. Sometimes it is bushy, but it also takes the character of a vine, and climbs over rocks, etc., by the aid of root-like out-growths from the joints of the stems.

The leaf of Virgin's Bower is similar to the above, but instead of one midrib it has three large veins running from the base (palmately net-veined). Its fruit is in hoary clusters.

Everlasting.
Antennaria Margaritacea.

There are two or three weeds known as Everlasting, which in certain sections of the country are killing out old pastures very rapidly. They are plants with a silvery or woolly appearance. The flowers are in heads, surrounded by chaffy involucres. They are the food-plants of Hunter's Butterfly, the chrysalis of which may be found suspended from the plant and enclosed in a thin web of silk interwoven with leaves.

Viper's Bugloss or Blueweed (see plate) is making about as rapid progress as any weed in Canada. Its violet-blue flowers are in showy, one-sided racemes, and each plant bears many racemes. The stem of the plant is rough, bristly, and spotted. The plant grows in meadows, along roadsides, and in waste places.

Ragweed. *Ambrosia artemisiæfolia.*

Ragweed ranks fifth in the list of most destructive Ontario weeds, and yet its introduction on many farms is within the memory of this generation. The flowers are in spikes, one to

six inches long, green and inconspicuous, though each individual flower is yellow. An average plant produces about five thousand seeds. The plants should be burned before the seeds scatter.

Couch-grass is a persistent weed which propagates itself by seed and rootstock. It is more destructive than Ragweed.

There are two species of Plantain common throughout the country. Both have

Couch-grass.
Agropyron repens.

Black Plantain.
Plantago lanceolata.

radical leaves, but one has very broad leaves and a long spike of flowers; the other has narrow leaves and a short spike of flowers on a long stalk. The latter is about as bad a weed as can possibly be encountered in lawns. It should be pulled out at its first appearance.

The Canada Thistle is, of course, our worst pest, and should be combated incessantly. Its habit of growing in patches is due to its underground stems, which make it almost as invulnerable as the hydra-headed monster which guarded the Golden Fleece. When one head was cut off several grew in its place. So with the Canada Thistle; when one is cut off, these underground stems give rise to several successors.

Then each seed is provided with an independent means of transportation, and the whole plant is so protected by its prickles that animals seldom touch it, except when it is cut and just withered.

Corn Cockle. *Agrostemma Githago.*
(Seeds poisonous.)

Wheat and hoed

crops, especially those which shade the young thistles, *e.g.*, corn, will keep them in check and eventually exterminate them.

Charlock.
Brassica sinapistrum.

Treacle Mustard.
Erysimum chieranthoides.

There is one whole family of plants which seem to have been created for the sole purpose of providing work for the human race in getting rid of them, although they contribute, incidentally, to our bill-of-fare, but only as condiments. This is the Cress family, whose flowers are characterized by a four-parted calyx and corolla, and by six stamens, four long

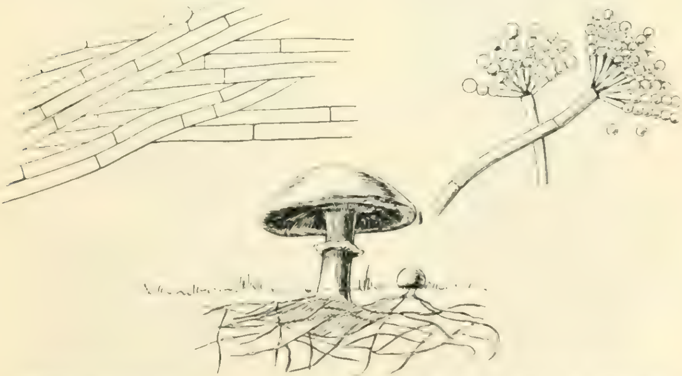
and two short. The fruit is a two-celled pod of varying shape. The flowers are either white or yellow.

The different species of Mustard are members of the Cress family. They stand a close second, in destructiveness, to the Canada Thistle. If not already abundant, each plant should be pulled and burned, as the seeds live for years in the soil, awaiting favorable conditions for development. If already established, summer-fallowing and hoed crops are best for combating them.

FUNGOUS PESTS

There are many injurious plants which are not usually recognized as plants at all. Some of these are Black Knot, Wheat Rust, Smut, Mould, Apple Scab, Potato Scab, etc. But they are plants, and are relatives of the well-known Mushrooms and Toadstools (Fungi).

It is quite easy to study Mould, which may be found on bread, preserved fruit, cheese, etc., and by a thorough examination of this we can understand all the others. Notice the two parts of Mould—the felt-like base and the fuzzy out-



Mycelium—Enlarged. Fruit of a Mould Enlarged

Mushroom, showing the underground part, mycelium.

growths from it. The base is a mass of long filaments, so small as to be seen, individually, only with the aid of a microscope. Similar filaments form the main structure of all fungous plants, but in many, *e.g.*, Mushrooms, they grow underground, and we see only a part of the plant, the fruit.

The fuzzy outgrowths from the felt-like base vary in different moulds, but in all consist of stalks at the ends of which are minute rounded bodies (spores), so small as to appear to the naked eye like dust. These spores are very light and are carried about by the wind. They alight in different places, and, if conditions are favorable, grow, and injure the object to which they have become attached. They may be killed by high temperatures (180° F. or higher).

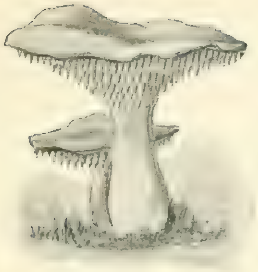
In the Mushroom, the spores are on the underside of the cap. At first they are flesh-colored, but turn black as they

Common Mushroom.
Agaricus campestris.

Fairy Ring (edible).
Marasmius oreades.

become ripe. In the Puff-balls, the spores are formed in a ball, from which they escape through an opening at the top. In other Fungi (Peziza, Lichens), they grow in little cups.

Fermentation in fruit is caused by small one-celled plants, something like the spores of Fungi. These spores do not grow in heads but in chains, or each cell remains by itself.



Hydnum repandum.

Edible Boletus. *B. Strobilaceus.*

Coral Fungus. *Clavaria.*

The Shaggy Mane. *Coprinus comatus.*

Edible Boletus. *Boletus edulis.*

Edible Morel. *Morchella esculenta*

EDIBLE FUNGI.

These forms are called Bacteria and are responsible for such common phenomena as the souring of milk, making butter rancid, etc. On plants they cause pear-blight and peach-yellows, and in human beings, certain forms cause such diseases as consumption, diphtheria, cholera, lockjaw, measles, etc.

Black-knot consists of two parts similar to mould. The knot is the fruit, while the felt-like mass grows under the bark of the tree (cherry, plum). Hence in cutting out the knot, a considerable portion of the branch (three or four inches below the knot) must be cut away to eradicate the disease. The proper time for cutting is in early winter and again in early summer. All parts cut away should be burned immediately, because if left unburned, spores will be formed, and carried by the wind through the country from tree to tree.

The parts of Grain Rust are not so apparent as in other Fungi, but both parts are there; the rust being the fruit, while the basal part of the fungus is buried in the stem of the grain on which it grows. This fungus has four stages in its life history, one of which is usually passed on the Barberry plant, though this stage may be omitted. Hence the spread of the rust may be prevented, or, at least, diminished, by destroying Barberry hedges.

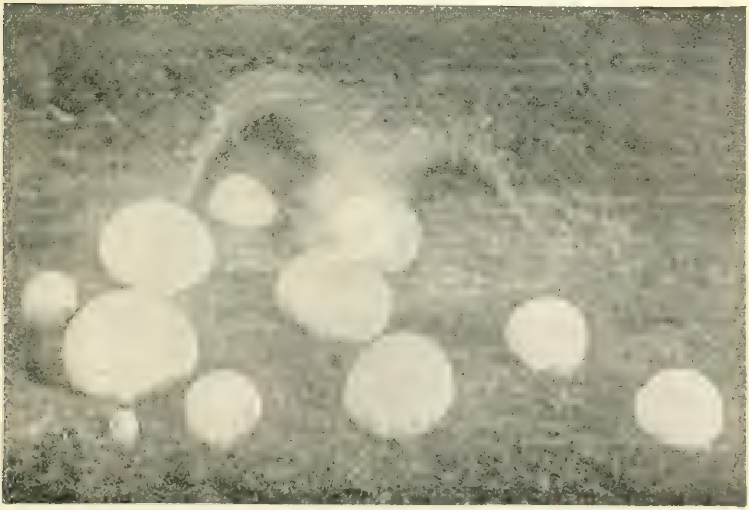
The smut of corn and of wheat is much in evidence, especially the former, when it forms fruit. The whole ear becomes a mass of black smut, which is really a mass of spores, ready to be carried by the wind to other fields. Needless to say such masses should be burned, and care should be exercised in the selection of seed, as some varieties are very susceptible to attack by this disease.

The scab on apples and pears is a fungus, by far the worst the fruit grower has to contend with. It makes the fruit

small and lop-sided. Spraying with Bordeaux mixture is the remedy. (See Reports of Farmers' Institutes, 1899-1900.)

A fungus, which attacks and kills the Balsam and White Spruce, was discovered in 1900. No remedies are yet known, consequently when the above trees are found to be diseased, they should be cut down and burned so as to prevent the spread of the disease. Our spruce forests are so valuable because of their usefulness in the manufacture of paper-pulp, that every effort should be put forth to preserve them.

It must not be concluded that all the Fungi are objectionable. As a matter of fact nearly all the larger species are edible, notably the common Mushrooms and Puff-balls. These



Giant Puff-balls Edible.

last grow to an immense size, a foot or more in diameter. The illustration shows a find near St. Thomas.

Plants like those just described are parasites; that is, they

secure their food, ready-made, from other plants. We have some much larger parasitic plants, which, on account of their size, are not so formidable to deal with.

The Dodder, a plant parasitic on many other plants, is spreading throughout Canada, having been introduced from Europe. It destroys the plant, *e.g.*, Clover, Flax, on which it grows.

Dodder.

Under beech trees in dry woods, a brownish plant may often be found. It grows upon the roots of the beech tree. Like all parasites, its leaves are very small, mere scales in fact, and there is no green coloring matter in any part. It has been called Beech-drops.

Squaw-root, parasitic on the roots of oak trees, looks exactly like a yellowish-white pine cone. The flowers grow in a cone-shaped mass.

Indian Pipe, which we tolerate because of its odd shape and because of its very respectable relatives, is the most interesting parasite. It belongs to the same family of plants as the Huckleberry, Wintergreen, Cranberry, and Mayflower.

Indian Pipe.
Monotropa uniflora.

PLANTS THAT ARE POISONOUS

While some plants prey upon insects and some upon other plants, there are several plants which have evil intentions towards humanity. These are the poisonous plants, some of which have been mentioned already, *e.g.*, Poison Ivy.

Stinging Nettle has adopted a pretty sure way of administering its poison by doing it up in sharpened capsules, a thoroughly up-to-date method. The prickles of the Nettle pierce the skin of the unwary nature student, then pour into the wound an irritating poison, formic acid. This is the substance which makes the sting of the bee or the bite of the spider so painful. The antidote is an alkali such as ammonia or soda. The caterpillar of the Io moth is covered with hairs, which have the same effect as the hairs of Stinging Nettle.

Poison Hemlock.

Buttercups and most members of the family to which they belong (Crowfoot) are poisonous when eaten. Indian Tobacco, a plant related to the Cardinal-flower, is extremely

poisonous. The Foxglove, a garden plant, contains digitalin, which has a marked action on the heart, making its beat slow and irregular. The seeds of Thorn-apple are poisonous, as are also the leaves and roots of May-apple.

Poison Hemlock grows in old gardens and in waste grounds, so that it is easily accessible. Its flowers are small and white, but they grow in clusters. The stalks of the flowers spring from the end of the stem and radiate in all directions like the ribs of an umbrella, hence such a flower-cluster has been called an umbel. The fruit is dry and two-seeded.

To be on the safe side, avoid all plants which grow in damp places, whose flowers are in umbels (especially compound umbels).

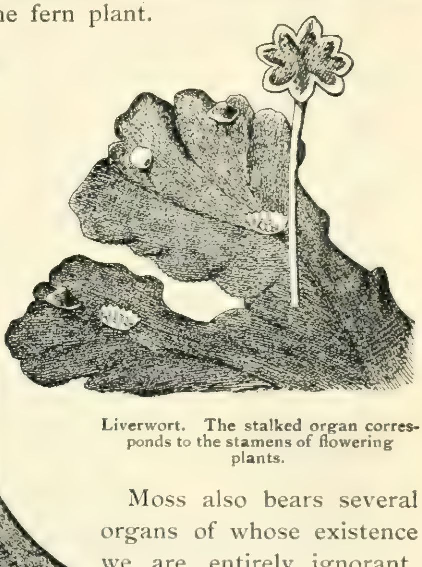
The most dangerous poisonous plants are the poisonous Fungi, because they are often mistaken for edible species. Unless you are an expert in mycology, you should avoid all Fungi except the common Mushroom which everybody knows by its flesh-colored gills, and the Puff-balls. Nina L. Marshall says: "It is better for the amateur not to eat of specimens which have stalks *with a swollen base*, *surrounded by a cup-like or scaly envelope*, especially if the gills are white.

SO-CALLED FLOWERLESS PLANTS

We have not yet touched upon a large group of plants, well-known in a general way, but still including many species which are looked upon as total strangers. We refer to the Ferns, Horsetails, Mosses, and Liverworts. Not only do we fail to recognize many of the members of these groups, but we do not know much about their structure and life-history. By way of arousing curiosity regarding these plants we shall point out a few interesting features.

The little fruit dots found on the backs of some fern leaves (fronds) are really groups of little sacs, each containing about a dozen small bodies (spores). Each of these

spores, under favorable conditions, will grow and produce a small, green, heart-shaped, leaf-like structure, which bears certain organs corresponding to the stamens and pistils of our ordinary flowers. By the union of cells produced in these organs a seed-like body is formed, which gives rise to what we know as the fern plant.



Liverwort. The stalked organ corresponds to the stamens of flowering plants.

Liverwort. The stalked organs correspond to the pistils of flowering plants.

Moss also bears several organs of whose existence we are entirely ignorant, or whose use is quite unknown to us. The stalk and sac at the end of the plant is a spore-bearing part, corresponding to the fern frond. Each spore develops into a structure quite unlike a moss plant, but from this the moss plants spring.

In the ends of the ordinary moss plants, usually in the midst of a rosette of leaves, there are organs, invisible to the naked eye, corresponding to the stamens and pistils of our common flowers. From the union of cells in these organs the spore-bearing parts spring.

Similar life-circles constitute the life story of the Liverworts and Horsetails.

A Common Horsetail.
Equisetum arvense.

Lichens are fungous plants, which are always with us, summer and winter. In fact, they begin to flourish when the cold weather sets in and other plants are taking a much needed rest. During the summer they manage to exist on the shady sides of trees and fences. Although they grow upon trees, fences, and stones, they are quite independent of them so far as food is concerned. They, however, damage their hosts to a certain extent by keeping the part under them moist and in a condition favoring decay.

A Common Moss, in fruit.

Lichen, growing on a board.

The little round, green-bordered, black-topped elevations, apothecia, on the surface of Lichens are spore-bearing

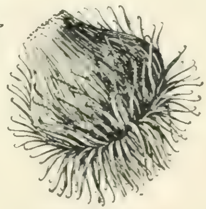
out-growths, and from these spores, scattered far and wide, new Lichens arise.

PLANT TRAMPS

Some plants learned the trick of stealing a ride before the modern tramp adopted that method of shirking the work necessary to transport himself across land or sea. With plants, the result is much more satisfactory than it usually proves with man. Plant tramps inherit the earth ; human tramps inherit the prison cell and the pauper's grave.

The plant tramps are commonly known as burs. These fasten themselves to our clothing, to the sheep's wool, to the cow's tail, or to any medium of a like soft nature. At the end of their journey they insist upon our assisting them to alight, which we do with scant ceremony. Occasionally we may throw them into the fire, but usually we throw them into rich soil, where they bring forth fruit, ten thousand fold or more.

Fruit of Galium.



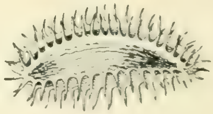
Head of Burdock.

The pitchfork bur, the fruit of the Bur Marigold, is a common bur, and what country child has not made baskets of the large heads of Burdock? These are heads of seeds, surrounded by a many-rowed involucre, each leaf of which is supplied with a little hook at the end.

The fruit of Cocklebur is much the same in appearance, but longer. There are only two seeds in it.

The little flat burs of our roadsides are the fruits of Hound's Tongue and of Beggar's Lice. The fruit of the

Burs of two species of Bur-Marigold.



Fruit of Carrot—Enlarged.

Carrot is also supplied with minute hooked appendages, as is also the fruit of the plants known as Bed-straw (Galium).

Whenever a fruit of any kind sticks to the clothing, it should be examined in order to discover the means by which it secures this free transportation.

THE FIRST NAVIGATORS OF THE AIR

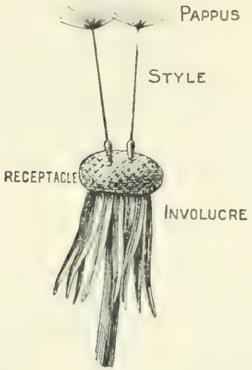
Santos-Dumont has recently astonished the world by taking his air-ship around the Eiffel tower. But before man came on the earth, Mother Nature had provided many of her seed-children with very successful, though simple, air-ships.

Each seed of the Dandelion has an air-ship and parachute combined. These seeds are so common as to be easily observed; yet how few know the way in which this doubly useful structure is evolved. Select a few plants and observe their development from flower to fruit. What do the flowers do at night and in wet weather?

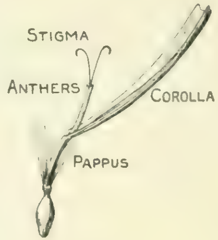
The flower of the Dandelion is a head of strap-shaped florets, surrounded by protecting layers of leaves (involucre).


HORNBEAM
BLUE BEECH
WHITE
ELM
TULIP TREE
GINGKO

These leaves close at night and in rainy weather about the gold of the lowly flower. Each flower is complete, but the calyx, which grows fast to the ovary wall, ends in fine, hairy bristles (pappus). After the corolla has fallen off, the tube



Head of Dandelion with two seeds.

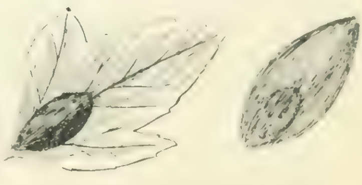


Single floret of Dandelion.

of the calyx grows in length and bears the pappus on its upper end. This forms the well-known, symmetrical, fluffy ball. As the involucre is now no longer needed, it is turned downwards, away from the part on which the florets grow, and the seeds are borne away on the passing breeze.

The seeds of Milkweed are also provided with tufts of down, but they have no long stalk. Many members of the same family as the Dandelion (Compositæ) provide their seeds with down.

Seed of Catalpa.



Fruits of Bluebeech and Ironwood.

The seeds of catalpa, bluebeech, and ironwood

trees have special developments, which enable them to be carried by the wind or upon water.

The seeds of maple, pine, basswood, ash, and sycamore trees are other examples of highly specialized structures. During the fall and also in the winter, seeds may be collected and studied. Make lists of seeds carried by wind, by water, by ice, and on snow; by birds, by animals, and by man himself. By making use of some or all of these agencies, plants have travelled around the world.

Plants have other ways of propagating the species. Some live from year to year by forming bulbs, *e.g.* Lily. Some have a thickening (corm) at the lower end of the stem which survives the winter, *e.g.* Indian Turnip. Some have thick underground stems, *e.g.* Butter-and-Eggs. Examine all the early flowering plants—Lily, Bloodroot, Spring Beauty, Dog's-tooth Violet, for these special structures. Examine the underground parts of plants which grow in patches, *e.g.* Canada Thistle. Cut in pieces these parts and place them in damp soil in a box. What is the result? What would be the effect of spading up these patches?

The study of a potato will give you a good idea of the nature of underground stems in general. The eyes are buds, and the fleshy part of the potato is a store of food upon which the sprouting buds feed until able to obtain food from the soil and the air. Is the arrangement of the eyes regular or not? Compare their arrangement with that of the leaves on the stem. Distinguish the roots of the potato plant from these underground stems. (Roots never bear buds). Look for buds in bulbs and corms.

What plants propagate themselves by runners? Discover other ways in which plants are multiplied.

Examine climbing plants and the structures by which they climb.

HOW SEEDS GROW

The interest in how seeds travel will arouse interest in how they grow. By planting seeds in soil in a glass bottle, so that they can be seen through the sides, you can observe how the young seedlings get out of their seed cases; how the roots strike downwards, or sometimes sideways, according to the looseness of the soil and the distribution of moisture; how roots behave in different soils; how the stems grow towards the light and the roots away from it; how different degrees of light affect the growth of a plant; what becomes of the seeds; and a hundred other things which can be learned only by personal observation.

Compare the leaves, stem, color, and strength of a plant growing in very dim light with one growing in strong light. From your observations on these, explain why forest trees are so much taller than trees which grow in the open.

WHAT PLANTS DO

Of course plants grow, produce leaves, flowers, fruit, and seeds. But there is method in all they do. Observe the arrangement of leaves on different plants to discover how they expose the greatest possible surface to light. Some plants have broad leaves at the base and finely divided leaves higher up, thus allowing light to filter through to the lower leaves. Some have leaves arranged in rosettes. Some, by different positions on the stem and by having the lower leaves set on long stalks, expose each leaf to the sunlight. It is quite wonderful to find how little the leaves of a tree shade each other, though on the ground there is almost complete shade.

Many plants move their leaves in a definite direction under the action of sunlight. The Prickly Lettuce (Compass-plant), sets its leaves in a general north and south direction. Observe the movement of Sunflower heads, flowers and plants in windows.

NOTE. See experiments with plants in Part II.

NATURE STUDY

PART II

METHOD OF NATURE STUDY

"A method is derived from a principle."—*Harris.*

The underlying principle of education is now considered to be some activity of the child, and this activity is essentially constructive. At different ages this constructive activity, or self activity, as Froebel styles it, has a different motive and finds expression in different ways. Up to the age of eight or nine years, the child is satisfied with activity for its own sake, and there is, consequently, direct and immediate response to stimuli. The child is not conscious of any definite end beyond the activity, nor does he consider the relation of means to end. There is, indeed, the need of constant direction by parent or teacher, in order to economize the energy which might, without supervision, expend itself in useless tasks.

From eight or nine to twelve or thirteen years of age, there succeeds a period characterized by a growing consciousness of some end to be attained by activity, and of means in relation to such end, but there is lacking the power of reflective attention to a variety of ends, and of judgment as to the value of the ends in themselves or of means to attain them. Dr. G. Stanley Hall says of this period: "Verbal memory is now at its very best, and should be trained far more than it is. We are now educating the automatic bases of both mind and morals, and habits are never so easily formed or made stable. Manual training and games should be extremely diverse, manifold, and thorough."

The energies of the child, therefore, must still be directed

by the teacher or parent, but the child must be conscious of the trend of his activities towards certain definite ends, in order that he may adapt means to attain them. The greater mastery over muscular movement makes accurate work possible. It is essentially a period of habituation. In Nature Study and in the sciences it is the period when facts are most easily learned and retained.

The natural mode of expression for this period is drawing, just as the natural mode of expression in the preceding period is modelling. Of course the child is not limited to any one mode in any period, but each period has its characteristic mode, which should receive particular attention from the educator.

The third stage, which follows gradually upon the second, is characterized by the exercise and development of reflective attention, that is—the child discovers ends and reflects upon their desirability, and upon means to attain them. Therefore, action should become more deliberate, independent, and permanent, and remote ends should be chosen in preference to temporary and immediate ends. And, again, we remind the reader that each stage includes all the mental activities, but in varying degree. Reflective attention should become the dominant factor in this third stage.

The child should now be thrown more upon his own resources in solving difficult problems, and the problems should not be presented ready-made, but should arise *as a part of life's experience*. Several problems may present themselves at once, and he should choose the one to be dealt with, and then consider the means necessary for the solving of the problem, whether it be a material or a mental one. The problem may be the construction of some article of use, or the analysis of another's thought. In either case there should be independent activity in its solution, and a motive sufficiently strong to arouse spontaneous activity.

Dr. Dewey says in *School and Society:* "No number of object lessons, got up *as* object lessons for the sake of giving information, can afford even the shadow of a substitute for acquaintance with the plants and animals of the farm and garden, acquired through actual living among them and caring for them. No training of sense-organs in school, introduced for the sake of training, can begin to compete with the alertness and fulness of sense-life that comes through daily intimacy and interest in familiar occupations. Verbal memory *can* be trained in committing tasks, a certain discipline of the reasoning powers *can* be acquired through lessons in science and mathematics; but, after all, this is somewhat remote and shadowy, compared with the training of attention and of judgment that is acquired in having to do things with a real motive behind and a real outcome ahead." And, speaking of the relation of manual training to education, he says: "We must conceive of work in wood and metal, of weaving, sewing, and cooking, as methods of life, not as distinct studies. . . . . Upon the ethical side, the tragic weakness of the present school is that it endeavors to prepare future members of the social order in a medium in which the conditions of the social spirit are eminently wanting."

It is, of course, impossible for us to introduce into Canadian schools, *as at present constituted*, a course of work at all like that which is laid down in the Elementary School of the University of Chicago, but it is possible to modify somewhat our antiquated methods, and make *more* use of our pupils' activities than we have been doing hitherto. The work here outlined is a humble effort to introduce into Nature Study some living activity, and to base it upon the fundamental activities of child nature. It is hoped that the attempt to adapt the principle of Dr. Dewey's school to our conditions will not entirely destroy its vitality.

APPLICATION OF PRINCIPLE

After what has been said about the principle of constructive activity and its action upon environment, there is little to be said on the question of method, except to show the practical application of the principle to each stage of child life. It is evident that our method must vary in these three stages. In each stage we have to consider: (1) The matter of study and how to obtain it; (2) The teacher's work; (3) The pupil's work.

In the first stage the matter of Nature Study is that with which the pupil can and does come in contact. The immediate environment of the child is the field of study. The extent of the analysis of the matter studied will be determined by the child's power of synthesis.

How shall this matter be obtained? In this primary stage we cannot depend to any great extent upon the pupil's ability to collect, unless under the direct supervision of the teacher. Consequently, teacher and pupils must make excursions together. But frequent excursions are impossible, and as we cannot take the children to nature, we must bring nature to the children. The remarks which follow, concerning school gardens, etc., are applicable to all three stages of child-life.

A part of the school yard must be set apart for the reception of plants of different kinds. The limit to the kinds of plants will be determined by the extent of the garden space, the nature of the soil, and the possibility of varying the conditions. If one part can be kept shady, another part sunny, another damp; if one part is loamy soil, another sandy, and another rocky, which, ordinarily, would not be found within a radius of many miles, all varieties of plants can be cultivated successfully. In stocking this garden with root-stocks, bulbs, and small trees; in planting seeds, and in caring for

all these, the most important facts about plants will be learned.

While a school-garden will furnish material for the study of plants, and will bring within reach the insects and birds which constantly visit them, it is necessary to have some more limited space in which living animals and plants may be brought into the class-room. There should be a cage, in which rabbits, squirrels, birds, etc., may be kept for a few days, observed, and then set free again.

A terrarium for the class-room is an essential part of a museum equipment, and may be stocked from time to time with the proper food-plants of the insects which are to be studied. A few young cabbage plants on which the eggs of the Cabbage Butterfly have been laid ; a young potato plant, with the yellow eggs of the Colorado Beetle ; a carrot, with the eggs of the Eastern Swallow-tail ; all may be used to stock the terrarium and to furnish matter for Nature Study, for weeks, at the proper seasons. Small animals, *e.g.*, toad, mud turtle, may be kept in the terrarium, and their habits observed, especially their burrowing when cold weather comes on. A small terrarium may be arranged to open to the outer air, and bees can be kept and observed in safety. One moth, kept in a cage on the window-sill, will attract others of its kind of the opposite sex.

Then, there must be an aquarium, small enough to be carried about, yet large enough to accommodate small-sized fish, cray-fish, mud turtles, etc A little care in observing and collecting water-plants will soon enable the teacher and pupils to keep a balance between plant and animal life without any further care than to keep the vessel clean, in a favorable light, and to replenish the water as it evaporates. Care must be taken to put just enough food in the aquarium so that none will remain uneaten. If too much is put in, the surplus must be carefully removed.

All these are for living things. But there is a place for dead things, and for pictures of living things, especially if the pictures are in colors. There should be stuffed specimens of representative birds and mammals ; preserved specimens of insects ; plants for reference, and for the purpose of showing how they should be preserved. But avoid trying to have a complete set of specimens, and above all things do not think that the study of dead specimens, especially of dead birds, is Nature Study. It is better to get your specimens of birds and mammals from a regular taxidermist, rather than to accept them from pupils, who should be discouraged from collecting birds and birds' eggs, because of the importance of preserving our birds from destruction. Encourage your pupils to expend their collecting energy on insects and plants.

A few life histories of butterflies, moths, and beetles should be prepared for reference, and for review work. Several typical specimens of plants, especially of those more difficult to obtain, should be pressed, dried, mounted and properly named, in order to show pupils how to do such work. Specimens from remote districts very properly find a place in a museum, as they will arouse interest in their native districts, and will extend the knowledge of familiar nature.

Finally, although these should not be studied analytically until the third stage of school life is reached, specimens of all the common minerals and rock of the country should be in every museum. If, corresponding to each mineral, pictures of the mines, of mining machinery, and of the mining country can be procured, geography may be made a much more profitable study. Sections of woods in their natural state, also polished and stained, should be obtained. Corresponding to these, there should be pictures of whole trees in their natural environment, if these trees are not within easy reach of the school.

THE WORK OF TEACHER AND PUPILS

The teacher will first of all select the material for study. Having done this, and having provided suitable quarters for it, he should direct the analysis and the expression of the pupils in each stage in an orderly way. He must not allow the material to be so great in quantity as to confuse the pupil, or to cause dissipation of energy, and yet must sustain interest by allowing the pupil's love of activity and discovery to find free play. The chief work of the teacher, at first, is wise questioning suited to the pupil's capacity. The pupils should assist in preparing cages, breeding-boxes, etc., for the museum.

We shall illustrate the work of teacher and pupil in all three stages in a series of outline lessons or studies making explanatory comments as we proceed.

I. OUTLINE STUDY OF AN INSECT

THE BUTTERFLY

FIRST STAGE—Five to eight years of age

MATERIAL.—Living Larvæ, Chrysalids, and Butterflies.

HOME :—

Pupils will state where they have seen each.

After observing in the class-room they should be told to observe at home and out of doors.

MOVEMENTS :—

Observe the larva crawl and eat. Tell how it does each. What does it do when disturbed?

Observe it moult, and describe the change in appearance.

Observe it preparing to pass into the chrysalis state.

Does the chrysalis move? How is it fixed?

Observe the butterfly emerge from the chrysalis.

What does it look like? How does the butterfly move about?

FOOD :—

What does the larva eat? Does the chrysalis eat?

Supply wild flowers, and observe the butterfly get nectar.

Feed the butterfly with a mixture of honey and sugar.

Tell how it drinks. How long is its tongue?

COLOR :—

Describe the color of each form.

STRUCTURE :—

What does the larva look like? Has it a head?

How many legs has it? Are they all alike? How many are alike? How, and for what purpose, does it use each kind?

What does the chrysalis look like? Has it a head?

What does the butterfly look like? How many divisions are there in its body? How many wings has it? How many legs has it? Observe its head, eyes, and antennæ, and tell what they are like.

EXPRESSION :—

In addition to oral descriptions, let children cut out paper butterflies and color them. Mould the shape of the chrysalis in clay.

SECOND STAGE—Eight to twelve years of age

The child is now able to depend partly on memory, and to imagine forms not actually seen, if aided by the teacher's description.

MATERIAL—Eggs, Larvæ and Food-plant, Chrysalis, Butterfly; Illustrations of several of each of these.

HOME :—

Where are the eggs laid? Does the mother watch over them?

Upon what plants does the larva feed? What plants will it not eat? Observe it at different times of the day.

Where is the chrysalis usually found? Describe its position. Gather information about it from different sources.

What flower does the butterfly prefer? Why? Where does it go at night? In winter? Obtain information from various sources.

MOVEMENTS :—

Review. Describe definitely its mode of walking, moulting, and eating. What changes are observed in its activity before and after moulting? Observe it breathe. Compare with your own breathing.

FOOD :—

Review. When does it eat most ravenously? When does it do most damage? On what does the chrysalis live? Compare the chrysalis with hibernating animals.

COLOR :—

How does its color harmonize with its surroundings? Compare colors of different species. How do they vary?

STRUCTURE :—

Count the number of rings (segments) in the larva, behind the head. On which segments are the legs situated? On which segments are the fleshy pro-legs situated? Compare larvæ of different species, actually present or pictured, and decide if they agree in these particulars. Make a drawing of the larva.

Compare the chrysalis with the larva, and tell how they resemble each other. Make a drawing of the chrysalis. Compare different chrysalids.

How many parts are in the butterfly? How many wings and legs? Where are they attached? Make a drawing of the whole and of each of the parts. Compare with larva and chrysalis.

HEAD, AND SENSE ORGANS :—

Examine the eyes with a lens and describe. Draw. Examine the antennæ. Compare with other butterflies,

and with moths. Describe and draw. Examine the tongue of the butterfly and compare with the mouth parts of the larva. Can it hear and smell? Experiment to discover.

EGGS :—

Observe a butterfly deposit its eggs. Where are they deposited and why? How many are deposited in a place? Keep in a box until they hatch. Observe development of the larva. Compare different stages with each other and with other larvæ. Make drawings of each stage.

THIRD STAGE—Twelve Years

The aim of the third stage should be to discover relations, especially of cause and effect. Whereas we have been more concerned about the where? how? and what? we now become concerned about the why? Finally, we classify the specimen as minutely as possible.

MATERIAL—As before, and in addition verbal descriptions of different forms of animal life, and an analytical key to each branch, partly, at least, the pupil's own work.

HOME :—

In addition to what has been learned before, the student should now determine what effect the larva has on its food-plant. Does it destroy it entirely or in part? How does the butterfly benefit the flowers? Why has the butterfly so long a tongue? What relation is there between the flowers it visits and the length of its tongue? What relation exists between the time of appearance of certain butterflies and of certain flowers? On the whole—is the insect harmful or beneficial to man?

MOVEMENTS :—

Why does it moult its skin?

Why does it become restless before moulting?

Of what benefit is this restlessness to the larva?

Has it any movements which are protective?

Read about the migration of butterflies and what they do in winter. Compare with other insects and with birds.

FOOD :—

Why are certain butterflies not found in Canada?

What determines their range?

Which is more easily killed by poisoning, the larva or the butterfly? Why?

If you find larvæ on different plants, find from your botany text if there is any relationship between these plants. They will probably belong to the same family.

COLOR :—

Observe if the different forms are protected by their color. Compare the color of larvæ in different conditions. Compare the color of the chrysalis with the surface on which it rests.

STRUCTURE :—

Compare all the butterflies studied, with one another, and with other insects, spiders, etc. Tell what is characteristic of all butterflies, which distinguishes them from moths, beetles, etc. Group the different species studied, according to their resemblances. How are they adapted to their mode of living?

LIFE HISTORY :—

Write a complete account of the life history of the butterfly.

Thus the teacher's work is in selecting the material and in directing the pupil's analysis, while the pupil's work is to discover facts about this material, and to give expression to each fact in some way. Finally, the student should summarize all these facts in a composition, which is virtually the story of the life of the animal studied. In doing this work

the mental power is increased in all directions, and the power of expression is incidentally cultivated in an interesting way.

The teacher can do a great deal to correlate Nature Study with other subjects of school study, *e.g.*, geography and physiology, and should base all training in expression, reading, drawing, and composition upon it.

II. OUTLINE STUDY OF A PLANT

BUTTER-AND-EGGS OR TOAD FLAX

Specimens of the whole plant should be obtained by the pupils. They should dig up a few and transplant them into the school garden, or, in the absence of an appropriate place, into a box which may be kept in the school-room window. The earlier in the season these plants are obtained, the more likely they are to flourish. Try to imitate in the school-room or yard the natural conditions of soil, light, and moisture. Imitate nature in your arrangement of plants.

Pupils should observe while collecting, the kind of soil, the location, amount of moisture generally present, all surroundings, and the date of collection. Were there few or many plants together? Were they pulled up easily or not? Were there bees or other insects about the flowers? Were there any larvæ feeding upon the plants? Do cattle or other animals eat the plants? How do bees or other insects enter and leave the flowers? Were there any insects about, which could not get at the nectar in the flowers?

In the class-room, root, stem, and leaves may be observed in detail. Everything should be discovered by the pupils themselves, if possible, without waste of time and effort, but there are always certain related facts which may be conveyed to the pupils through pictures or by words, especially

in higher classes. The one thing to avoid is the attempt to force the pupils to learn mere forms without actual assimilation. The method of arousing mental activity varies in the different stages, as previously stated, and this holds good in the study of plants as in any other study.

FIRST STAGE

What part of the plant grows above ground? What is the nature of the underground part? Where was this particular specimen found? Tell whether it grew in shade or in sun; in dry, moist, or wet soil; or in water. How many plants grew where the specimens were found? How close together did they grow? Were any of the plants eaten off by animals? What insects were noticed about the flowers? What were they doing?

PART OF PLANT ABOVE GROUND :—

How high does it grow? How wide? Are there branches? What kind of leaves are there? Do all the plants bear flowers? What color are the flowers? What odor? How many are on each plant? How are they arranged? Are all the flowers open at the same time? What do they look like? Cut out paper flowers and leaves to look like the real ones. Color them.

PART OF PLANT UNDERGROUND :—

What kind of structure do the branches grow from? (Give name, *root-stock.*) How many branches grow from one root-stock? How long is a root-stock? Find the fibrous parts growing downwards from the root-stock. How many are there? How long? Cut up the root-stock into several pieces, and plant all the pieces.

FRUIT : —

What is the shape of the fruit? Is it good to eat? Do animals eat it? How many seeds are there in it? Mould clay to the shape of the fruit.

SECOND STAGE

Review conditions of growth as in first stage. What other plants are growing near it? Compare conditions of plants found in different localities. Do the plants vary with conditions? Compare plants which grow in shade and in sun. Compare plants which grow in moist soil with those in dry soil. What kind of soil seems most favorable to the plant? Why are the plants found in patches? If animals will not eat them, discover why. Observe how bees enter and leave the flowers. What insects cannot enter? Why? What do the bees get from the flowers? What do they carry from one flower to another?

PART OF PLANT ABOVE GROUND :—

Review work of first stage. Where does the plant grow higher — in sun or in shade? in sand or in clay? in moist or in dry soil? How high are the highest plants observed? How wide are the widest? Look at the plant from above. Describe the appearance of the leaves. How are they attached to the stem? Why are they not placed one above the other? Do the leaves change position in sunlight and at night? Make drawings of the whole plant to show various points observed.

Describe a leaf fully and draw it. Compare with leaves of other plants. Why are the leaves narrow? Compare the number of leaves with the number on the sunflower or other large-leaved plant. Make a diagram showing the order in which the flowers open. What advantage is it to the plant to have flowers opening successively? Make a drawing of a flower and of the whole plant.

FLOWER :—

Examine the different floral organs: — calyx, corolla, stamens, pistil. How many parts are in each? Show by diagram where each part is situated. How is the corolla

adapted to invite the bee to visit it? What attracts the bee? Observe one alight on the flower, and tell just what happens as the bee alights, enters, and leaves. What part of the bee becomes covered with pollen? What becomes of this pollen? Where is the nectar found?

NOTE.—It is assumed that the pupils have examined flowers of simple structure, such as the Buttercup, before examining this one.

FRUIT :—

Is it dry or fleshy? How long does it take to mature? Does it split open when ripe? How? Why? How many cavities are in the fruit? How many seeds? Where are the seeds attached in the fruit? How are the seeds discharged from the pod? Examine a seed and make a drawing. How is it made so as to be carried away? What agent will carry it? Preserve some seeds and plant them next spring. Compare with other seeds in shape, size, color, etc.

PART OF PLANT UNDERGROUND :—

Account for the plant growing in patches. How does the root-stock grow in length each year? What becomes of the old part? What happens to the plant in winter? Preserve some of the root-stocks and plant them in spring. (Give name, *perennial*, for a plant which lives from year to year, after pupils have discovered this to be the fact.) Compare root-stock with a potato tuber, bulb of Lily, or corm of Indian Turnip. Is the root-stock a stem or a root? Why? Compare roots with branches in size, shape, structure, as far as possible. Compare the roots of this plant with those of other plants.

THIRD STAGE

Under each heading, review the work of preceding stages.

Why do the plants grown in different conditions vary? In what kind of soil would a plant of this nature spread most rapidly? How can plants that grow in patches be destroyed? What other plants grow in patches? Compare

with this one after inferring in what respects they should agree. What is the adaptation of the structure of the flower to that of the bee?

PART OF PLANT ABOVE GROUND :—.

Determine the exact leaf arrangement of the leaves on the stem. Why are they arranged in this way? Is the stem woody or soft? Are the leaves net-veined or parallel-veined? Write a full description of stem, leaf, and mode of flowering, using technical terms. What other flowers resemble this one in mode of flowering (inflorescence)? Is the plant an exogen or an endogen?

FLOWER :—

Write a full description according to some prescribed form, stating the number of parts in each whorl, and the relation of the whorls to one another. Do this first in simple language and gradually introduce technical terms, such as *gamopetalous*, etc. Determine the relation between the position of stamens and stigma which favors cross-fertilization by bees. What other flowers have closed corollas? Why? Why is the corolla spurred? What other flowers have spurred corollas? Compare the lengths of the spurs in different flowers. By what other means do plants favor visits by bees? What other insects cross-fertilize flowers? Obtain further information from books on Nature by Darwin, Gibson, Grant, etc. Classify the plant.

FRUIT :—

Write a full description of the fruit. Compare with other dry, dehiscent fruits. In what ways does the fruit favor the preservation of the plant?

PART OF PLANT UNDERGROUND :—

Compare the structure of the root-stock with that of the stem above ground. What is the difference between root-

stock and root? Determine the age of the root-stock by counting the rings of wood. Examine the root-stock in the fall and see what preparation has been made for next year's growth. Compare with annuals and biennials.

III. OUTLINE STUDY OF A BIRD

THE ROBIN

Robin's Nest and Eggs.

FIRST STAGE

HOME :—

Where do you see it? In the trees? On the ground? When? In summer? In winter?

MOVEMENTS :—

What part of the body does it use in flying? Notice the movement of the tail when it alights. How close can you get to it before it flies?

FOOD :—

Watch it pulling earthworms out of the ground after a shower. What else do you see it eating?

COLOR :—

What parts are dark? pure black? white? red?

SONG AND CALL :—

What kind of a call does a Robin make? Does the Robin move its body when it makes its call? When does it sing? In spring? In the fall? At night? In the morning? When it is raining? Have all the Robins the same song?

APPEARANCE :—

Look for its eyes, ears, nostrils. What is the shape of its bill? What is it made of? Has the Robin a tongue? Has it teeth? What is the shape of its tail? What color have the legs and feet? How many toes has it?

NEST AND EGGS :—

What is the nest made of? Where is it found? On the ground? In a bush or a tree? How many eggs are there? Of what color are they?

SECOND STAGE

HOME :—

When do you see it first in the spring? When last in the fall? Where does it go in the winter?

MOVEMENTS :—

Does it walk, or hop along the ground? What part of the body does it use to balance itself when it alights? How does it keep its feathers clean and smooth? In what position does it sleep?

FOOD :—

What insects and what fruit do the Robins feed on? What do they find to give the young? How do they prepare it? Why are they so active after a shower?

COLOR :—

Are the Robin and his mate both of the same color? Which is the brighter? How does a young Robin differ in color from an old one?

Song and Call :—

Does it sing when it is flying? What position does it generally choose? a low branch, or the top of a tree? Does it open its bill when it sings? Has it more than one kind of call? Does its call mean anything? Compare with other birds.

Nest :—

When does the Robin begin to build? What different kinds of places does it build in? · How long does it take? How does it carry the mud? How does it shape the nest? Does it use the nest as soon as it is finished? Is the same nest ever used twice? How many times in the year does the Robin build?

The Eggs :—

Of what shape are the eggs? How long is it before the second egg is laid after the first? When does the mother-bird begin to brood? When does she leave the nest to feed? Does the male bird ever sit on the nest? How long before the first egg is hatched? The second?

The Young :—

Have they any feathers at first? Are their eyes open? When do you notice any change in their appearance? What food do they receive? Do both parent birds help to feed them? How long do they stay in the nest? Do they all leave at the same time? What are their chief enemies? How do the old birds keep track of them after they leave the nest? How long do the old birds look after them?

THIRD STAGE

Home :

Note the exact date of migrations. Why does it return so early and leave so late? Do both male and female

birds return at the same time? How far south do they go in the winter?

MOVEMENTS :—

Note the points which facilitate flight—the covering of feathers, shape, air sacs in the bones which can be inflated. Compare its flight with that of the Goldfinch, Redheaded Woodpecker, Bobolink, Partridge, Swallow, etc.

FOOD :—

In what way does it help or injure the farmer? Compare its food with that of the Bluebird, Wood Thrush, etc.

COLOR :—

Why does the male bird wear brighter colors than the female? Why is the young Robin not brightly colored? What points of resemblance does it bear to the Ground Robin or Towhee, the Wood Thrush, and the Bluebird? What is the legend as to how the Robin's breast came to be red? At what season does the Robin moult?

SONG AND CALL :—

Why does the female bird not sing? What time of the year does the Robin sing most? Why? What do the parent birds do when their nest is in danger? Compare the song of the Red-eyed Vireo, the Tanager, and the Grosbeak with that of the Robin. In what way do the vocal organs of a bird differ from those of other animals?

NEST, EGGS, AND YOUNG :—

Make minute observations as to the time occupied in nest-building and brooding. Make accurate notes concerning the instincts and actions of the young birds. Compare the nesting habits of the Robin with those of the other members of the Thrush family.

General Features :—

Which is the larger, the male or the female bird? What are the characteristic movements of the Robin, by which you might recognize it at a distance? Do the same Robins nest together year after year, or do they mate every spring? Do the same Robins return every spring to the same localities? What progress can you make in taming them? Do the Robins ever molest other birds, or fight among themselves? The writer remembers watching a Robin who fought persistently, day after day, with his shadow in a bright basement window, returning to the combat time after time after being driven off.

Give an account of the Robin, either in story or essay form.

Read Lowell's essay on "The Robin."

SUGGESTIONS FOR CLASS WORK ON MAMMALS

It is impossible to lay down any hard and fast rules for the study of animal life in the class-room, for the conditions of study vary considerably with the different schools and different localities. But some general suggestions can be made which may be some guide to the teacher in undertaking the actual work in the class.

Naturally no attempt must be made in the junior classes to cover the field of study indicated in this book. But a beginning may be made, for even the youngest pupils can readily understand what is meant by wild animals, in contrast to the ordinary domestic animals, and in most cases they are already familiar with at least the rabbit and the red squirrel. A little talk on either one will bring out how much the pupils know, and the teacher can stimulate further interest by telling them a few of the interesting things regarding the way in which the squirrels or rabbits live. In

the course of a few such talks, the pupils will, indirectly, learn most of the good and bad points regarding them, and will be able to distinguish readily between the chipmunk and the red squirrel ; and if, in the course of these first studies, the teacher can read to them,or tell them stories about these animals, or can tell them something of his own experiences in making their acquaintance, it will add very much to the interest of the class. Of course, the first thing to be impressed upon the minds of the children at the very outset of their study is the fact, that it is their duty to protect wild animals from molestation and persecution. Strange as it may seem, this is one of the most difficult things to persuade boys and girls to do, and yet unless Nature Study is successful in this, it fails in its chief purpose as a subject for study in the schools.

After rabbits and squirrels have been dealt with by the method indicated above, the interest of the class may be turned towards other smaller mammals, field-mice, moles and bats, and the same method followed. A delusion trap may be used to secure specimens of field-mice for the children to examine, and they will themselves readily distinguish between the two common kinds. The teacher can tell the class at the same time about the moles—the mice which live underground, and the bats—the mice that fly in the air.

A third stage in the study of the wild animals will treat of the woodchuck and the skunk. Every country school-boy knows of a woodchuck's burrow, and the peculiarities of the skunk are sufficiently well-known by all children to make the study an interesting one. The good qualities of the skunk should not be overlooked in the study of his various characteristics, and the desirability of his protection should be emphasized.

The remaining Mammals, the raccoon, the muskrat,

the black squirrel, and the flying squirrel, which are less familiarly known than the preceding species, will be dealt with in the senior classes. The teacher should, in the meantime, stimulate the interest of the pupils in animal life in general by reading to them interesting stories, such as Long's and Seton-Thompson's, concerning the Mammals not included in the regular course of study; but the reading of nature stories must not be allowed to interfere with the regular study of animal life as it actually exists in the district in which the school is situated. By the time that the pupil is ready to leave the public school, he should be able to name the different animals which are found in his own neighborhood, and should know the important facts concerning their manner of living,—their food, homes, defences, season of activity, usefulness, etc.

Nature Study, aside from its value in training the scientific and æsthetic faculties, may be turned to distinct advantage by the teacher to give interest to a subject generally disliked by most pupils,—English composition. The boy who rebels against the task of constructing a "padded" composition on an abstract theme, generally delights in telling about what he has actually experienced in the outside world. His interest in the woods and fields is almost invariably keen, and a judicious selection of nature subjects by the teacher seldom fails to produce satisfactory results. The pupils may be asked to give an account of their own observation of facts, of which they have already learned in class; or they may be required to reproduce an animal story which they have read or heard, or to give the substance of a passage of poetry which has for its theme some phase of animal life. The following subjects may perhaps suggest some lines which the teacher may follow in the senior class, either in his own talks to the class, or in utilizing the study of Mammals for work in composition.

1. The Winter Sleepers. 2. The Tell-tale Snow. 3. The First Spring Day. 4. Chicken Thieves. 5. The Hay Field. 6. The Night Walkers. 7. The Hunters and Fishers. 8. The Rail Fence. 9. Visitors to My Garden. 10. Twilight in the Woods. 11. Protection and Defence. 12. The Houses in the Woods. 13. Making Friends. 14. The Autumn Harvest. 15. The Creek. 16. "Nothing Walks with aimless Feet." 17. Scent. 18. The Service of Tails.

The teacher will find no difficulty in securing suitable subjects for the written work in the junior classes. The written exercise does not require to be long, and simple subjects will no doubt be suggested by the work of the class.

The poets, for various reasons, have written very little on the wild animals, but certain poems such as Emerson's *The Mountain and the Squirrel;* Burns's *On Seeing a Wounded Hare*, and Wordsworth's *Hart Leap Well*, bear indirectly on the study of animal life, and the teacher cannot do better than to connect Nature Study with English literature by reading these poems, and others on the same subject which may come to his notice, to his classes when the opportunity presents itself.

An outline of the study of the Red Squirrel is given as a guide to the study of the wild animals in general.

OUTLINE STUDY OF A MAMMAL

THE RED SQUIRREL

The mountain and the squirrel
Had a quarrel,
And the former called the latter "Little Prig."
Bun replied: "You are doubtless very big,
But all sorts of things and weather
Must be taken in together
To make up a year;
And a sphere:
And I think it no disgrace
To occupy my place.

If I am not so large as you,
You are not so small as I,
And not half so spry:
I'll not deny you make
A very pretty squirrel track.
Talents differ; all is well and wisely put,
If *I* cannot carry forests on my back
Neither can *you* crack a nut."

Home :—

Do you find it in the winter? In the summer? Where do you find it?

Movements :—

Can it run fast? How does it get from one tree to another? Does it run along the ground? Along the fence?

Food :—

What does it live on in the winter? In the summer?

Color :—

What parts are red? White? Are there any black marks?

Calls :—

Listen for the loud *sill—l-l-l*, which it makes sometimes. What sort of a sound does it make while it is watching you?

Parts :—

What part of the Squirrel is most noticeable? How many claws has it on each foot? Has it any ears? Any nostrils? Any teeth? How many?

SECOND STAGE

Home :—

Where is its nest in winter? In summer? What is its summer nest made of?

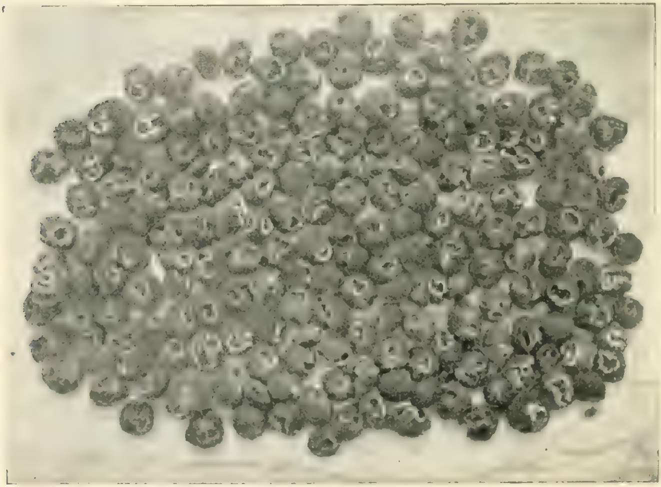
Movements :—

Notice it stop from time to time as it runs along the

fence. Why? If you chase it, which side of the tree does it go up? What does it use to break its fall if it misses its footing? How does it hold a nut to crack it? What different positions does it stand in? What is its position when it is very hot? What movements does it make when it is excited? How does it clean its face and its fur?

Food :—

What different kinds of flowers and seeds does it eat? In the spring, watch it eating the flowers and seeds of the different trees. It is also fond of sap, and gnaws the



Nuts filed by Red Squirrels.

branches to get at it. Do you ever find it stealing birds' eggs? Watch it eating beech-nuts in the fall. What kinds of nuts does it store up for the winter? Where does it store them? Does it ever bury nuts in the

ground? How does it succeed in extracting the kernel from a nut? Will it eat meat of any kind?

COLOR :—

Notice the black marks along the sides. Do all red squirrels have them? Are all red squirrels the same shade of color?

CALLS :—

Which of the calls is given as a sign to other squirrels? Which is expressive of excitement? Note the peculiar combination of tones in the ordinary call of the squirrel. Its sharper tones are combined with a low, hoarse note, which makes it appear as if there were two different voices.

PARTS :—

To what various uses is the tail of the squirrel put? Which are the stronger —the fore or the hind legs? Make a drawing of the squirrel.

THIRD STAGE

HOME :—

Where does it pass most of its time in the trees or on the ground? What parts of its body are specially adapted to its life in the trees? Compare it with the chipmunk in this respect. Put up a bird-box in the neighborhood of a red squirrel's haunts and watch to see if he will occupy it.

MOVEMENTS :—

When pursued, how does it elude its pursuers in climbing a tree? Does it ever take refuge in a ground hole? How is it that it is able to pass from one tree to another so readily? How does it act when its surroundings are strange and unfamiliar?

FOOD :—

In what respect does it differ from the black squirrel in

storing up its winter supply? What precautions does it take against surprise when eating seeds or nuts in a tree? How does it sometimes make sure of getting its harvest of nuts which are in danger of being carried off by other squirrels?

COLOR :—

How does it differ from a chipmunk in markings? When does it get a change of fur? How do the colors of the red squirrel harmonize with its surroundings? Compare it with other animals in this respect.

CALLS :—

Distinguish between the calls of a red squirrel and those of the black squirrel and the chipmunk. Note the name, *chickaree*, and compare it with the sound made by the squirrel when excited.

PARTS :—

What is the derivation of the word *Squirrel?* Upon which of the organs does the squirrel depend most for food? For safety? What is peculiar in the way in which the eyes are set in the head? Compare with those of a human being. How are the teeth adapted for chiselling the food from nuts? It is said that a squirrel can move either of its lower teeth up and down independently of the other. Disprove or verify this. How is it adapted to its life in trees?

YOUNG :—

When does it rear the first litter? Where? How many litters does it rear in the season? Note the fact that the male squirrels are driven away from home upon the arrival of the young squirrel family. Why? If possible, study the habits and instincts of the young squirrels.

RELATIONS TOWARDS OTHER ANIMALS :—

How do the red squirrels treat the black squirrels? Why? What are the chief enemies of the red squirrel? What animals? What birds? Last fall the writer watched a red-headed woodpecker chase a red squirrel round and round a tree. The pursuit was kept up nearly all afternoon. Why do the birds dislike the red squirrel? Is it easily trapped? Contrast it with the black squirrel in this respect. How does it attempt to get out of captivity? Can you tame it?

Give an account of the Red Squirrel either in story or essay form. Read Thoreau's description in *Walden*.

NOTE.—If you desire to get a red squirrel for observation, place a box with a hole in one end on a fence in the woods Attach a long string to a slide or door in such a way that it can be instantly pulled shut. Put some shelled nuts in the box or on the fence. Early in the morning, or late in the afternoon, when the squirre's are most active, conceal yourself a short distance off and await developments. Sooner or later a squirrel will go into the box, and a sharp jerk on the string will secure it. A cage may be improvised by covering the front of a large packing case with wire netting, and providing it with cross pieces, and a sleeping-box filled with grass. Be careful to supply it with fresh food and water every day. A squirrel which is kept through the winter in this way should be let go in the spring.

SOCIAL SIDE OF NATURE STUDY

In order to make Nature Study an integral part of education, it must bring into play the constructive activities by which the social life of the race has been evolved. This development has been intimately associated with what we eat, wear, and live in, and with the tools by which the raw materials have been converted into food, clothing, and shelter for the race in different ages. In order to understand the present complex social organization, the child must repeat the more primitive and typical processes of life, but under more ideal conditions. The following series of lessons is suggested as being typical of the important processes of social development. For food—wheat may be taken ; for clothing—wool, linen, cotton, and silk ; for building materials—wood, iron, stone,and brick.

In each case the study of these should be correlated with history, geography, arithmetic, and with all the modes of expression—modelling, drawing, writing and speaking.

WHEAT

Plant some wheat, observe its growth and development, partly, at least, as outlined in the study of "Butter and Eggs."

Compare the quantity sown with the quantity reaped, and thus estimate yield per unit area. Find out what is the average yield per acre in Canada.

Work out experimentally the process of manufacturing flour, from the crude crushing of wheat with stones to the

finished products of a roller mill. Visit some modern roller mill. This work will be correlated with history and geography.

Obtain and compare various kinds of flour.

Compare bread made from different kinds of flour.

Where provision is made for Domestic Science, the making of bread will form a step in the study. The value of the whole wheat as a food should be made clear by the study of the different constituents of the grain—starch, albumen, and cellulose.

What kind of soil is most favorable for wheat production? How can poor soil be made favorable for wheat? How can good soil be prevented from becoming poor?

FLAX

Seeds should be planted, and the whole plant may be studied as outlined for "Butter-and-Eggs."

After the plant has been thoroughly studied, secure several bundles of the ripe flax plant, pulled in the ordinary way. Why do they pull it?

Suggest means of threshing, and discover the use of the seed.

Secure products of the flax-seed and discuss their value.

Break the stems of flax with the fingers. Describe what happens.

Lay the straw out-doors for several weeks. Compare with straw which has not been laid out.

Suggest other ways of "retting."

Let pupils devise a mechanical method of separating the woody and the fibrous parts of the flax straw. Show pictures of modern machinery for the purpose.

Work out primitive ways of spinning, weaving, bleaching, etc.

At almost every step in the study of flax, history, geo-

graphy, drawing, composition, etc., can be correlated. When did people spin by hand? When was the spinning-wheel introduced? What was the effect on related industries of improved machinery? Where is the great centre of the linen industry? Why?

SILK

After studying one of our common moths, *e.g.* Polyphemus, the pupils will be quite ready to understand the life history of the Silkworm from egg to cocoon.

Secure pictures of the different stages and compare with the stages in the life of Polyphemus and other moths.

Cocoons may be obtained from the large silk-manufacturing firms, and may be unwound by placing in warm water, which will set free the end. Unwind the whole cocoon by hand. This will require several hours' work. After this slow process, the pupils will be ready to suggest the use of machinery for unwinding, and pictures of modern machinery may be shown.

If pupils are properly directed, they will rediscover in a short time the use of the shuttle and the means of throwing it, first by hand, then by hand-worked levers, and, finally, by machine power. With improved throwing power, wider cloth may be woven, and the steadiness of machine-weaving will be seen to be a great improvement over hand-weaving.

How may a strong silk thread be made from the fine silk of the cocoon? Find out how many strands there are in a silk thread.

Compare silk with cotton, linen, and wool. Why is it more expensive? Can it be produced in Canada? Which of our moths spin good silken cocoons? Why not make use of these to manufacture silk? What other animals spin silken threads?

The relation of the climate to the growth of the Silkworm

will make a natural connection between the study of silk and geography.

What are the silk-producing and silk-manufacturing countries?

WOOL

Make a thorough study of the domestic sheep.

Secure wool, the whole or part of a fleece.

Show pictures of sheep-washing, shearing, etc.

Discuss the use of sheep as food. What conditions are favorable for sheep growing? Why have New Zealand and Australia become famous sheep-raising countries?

Compare different parts of the fleece by examining the length of the wool fibre. Why do wool fibres adhere to each other so readily? (A microscope may be necessary to discover this). Compare different kinds of wool.

Try to prepare the wool for spinning by using the fingers only. Let the pupils see the advantage of some sort of instrument to separate the wool fibres. The pupils may invent crude carders, spindles, etc.

Show them a spinning-wheel, or a picture of one.

Have pupils repeat as many as possible of the steps in the process of preparing wool for use in making cloth.

After the white yarn has been produced, discuss dyeing, weaving, knitting, etc., as with flax and silk.

Why should linen and cotton be cheaper than wool and silk? Which is the warmer? Why? Of what use is wool to the sheep? Is it of the same use to man? Of what use is silk to the silkworm? Is it of the same use to man? Of what use is cotton to the cotton plant? Of flax fibre to the flax plant?

COTTON

A similar study should be made of cotton from the seed up to the finished product. Although cotton does not mature in this country, seeds will germinate in window-boxes, and

the matured cotton-bolls may be obtained from friends in the South, or such material may be a part of the regular school supplies.

There is no limit to the field of study which may be gradually opened up by the study of these raw materials and their manufactured products. Questions about suitable soil, climate, and rainfall will necessarily arise. Transportation problems must be considered, and as whole districts become devoted to their most suitable products, the importation into them of other products not raised there raises the question of commerce and interchange of products.

The use of steam-power and of machinery leads to the study of coal and iron, their relation to each other and to other products. Later, physical and chemical problems of every kind will naturally arise.

WOOD

The best introduction to the study of wood is by using it in the construction of some useful article. In discussing the use of the article, the kind of wood best suited for it must receive attention. This will bring before the pupils the different properties of different woods, and pupils should discover which kind of wood is best adapted for the required article. Naturally the first articles made should be simple, so that the task of choosing the wood should be reasonably easy.

It is evident that a great part of the process of preparing the wood must be omitted. The cutting down of the trees, hauling the logs, sending them down the river to the mills, sawing them into lumber, can be shown by illustrations, and this is an important part of the study of wood.

When should the trees be cut? Why? Does the mode of sawing affect the use of the lumber for different purposes? Where are saw-mills likely to be situated?

Experiment with different woods in polishing, staining, filling and varnishing. A pupil should soon discover the importance of filling coarse-grained wood, such as oak, ash, and walnut, before varnishing. They could even suggest good fillers, if they have learned something about the nature of wood and vegetable substances in general.

When the wood of a tree has been used in making some article, the pupils will be interested in learning where the tree grows, the soil most suitable for its growth, and its habits of growth. Is it an evergreen or not? What change occurs when winter comes on? Which is better for producing lumber—a tree growing in a forest, or one growing in the open? Why? How is the tree propagated? How fast does it grow? How soon could a forest be produced? How many of the seedlings mature? Compare the seedling with the mature tree. How can the age of the tree be known?

Study all the parts of the tree in relation to each other trunk, branches, leaves, flowers, fruit.

Learn to recognize the tree by its general outline; from its bark; from a single twig; from a single leaf; from the flower, and from the fruit. Until this can be done, the tree is not known.

IRON

Varieties of iron should be examined and tested as to malleability, flexibility, hardness, and use for certain purposes. (This will include very elementary work.)

Make simple experiments in tempering iron wire. Heat to red heat and cool suddenly by thrusting into cold water. Try cooling suddenly at different temperatures, and compare hardness by using a file on the iron.

Compare the effect of suddenly cooling other metals, *e.g.* copper.

Explain that the hardness, malleability, etc. of iron depend partly on the quantity of carbon which is mixed with it.

Place small pieces of iron in different acids. The black specks which invariably remain after all action has ceased are particles of carbon, which are not acted upon by any acid. Discuss also the effect upon iron of mixing nickel and other metals with it.

Magnetize short strips of iron, needles, nails, etc., by drawing them across the pole of a magnet several times, *always in the same direction;* for a needle, draw either from point to eye or *vice versa.*

Which makes the better magnet, hard or soft iron?

Try to magnetize copper, tin, zinc, etc.

Refer to works on Physics for other ways of magnetizing iron, and for the application of such magnetized iron to various instruments, such as telephones, telegraphs, door-bells, etc.

Observe the rusting of iron. Under what conditions does it rust most readily? How may it be kept from rusting? Weigh a clean piece of iron; then let it rust and weigh it again.

Secure iron ore of various kinds. By observation where possible, by use of pictures, from descriptions, etc., learn where it occurs, how it is mined, transported, etc.

Scratch glass with the sharp edge of iron pyrites. File iron pyrites. Note change in color.

Powder some iron pyrites. Heat the powder in a test-tube in the flame of an alcohol lamp, or in any blue flame. The substance given off and deposited on the sides of the test-tube is sulphur. Explain that iron pyrites is a combination of iron and sulphur, and that all processes aim at the separation of this sulphur and the obtaining of pure iron. By "roasting," that is,heating with coal, charcoal, or coke, the sulphur is displaced by oxygen, and red oxide

of iron is produced. The oxygen may then be removed by more intense heating with charcoal or with coke, in specially prepared furnaces.

This latter process can be shown on a small scale by heating a mixture of powdered oxide of iron and moist carbonate of soda with a blowpipe flame, in a hollow made in a piece of charcoal. Small pieces of impure iron may be obtained in this way after several heatings.

Bring a magnet near these pieces. Place some of them in an acid *e.g.*, hydrochloric. Hammer small pieces to discover whether the iron is brittle or malleable.

Compare this simple process with the more complex process of reducing iron ores in blast furnaces. In these furnaces alternating layers of coal or coke, oxide of iron and limestone, are placed until the furnace is filled. The whole is then heated by a current of hot air. The coal reduces the oxide of iron to metallic iron, which takes up a little of the carbon, and melts. The limestone acts upon the foreign matter in the iron ore, forming with it the "slag" under which, at the bottom of the furnace, the molten iron collects. The molten iron is drawn off, and the blast furnace is filled in again at the top as the first charge is drawn off. In this way the process is made continuous.

LEAD

For comparison and contrast with iron, lead is a good metal to study.

Examine lead in the same way as iron was examined. What properties make it useful for water pipes? Heat some lead in an iron spoon in a blue flame. Which melts the more easily, iron or lead? Carefully drop lead from a height of several feet into cold water. What is formed? Explain the manufacture of shot, and the use of shot-towers. Why do we use lead for shot instead of iron?

Obtain some of the common lead ore—galena. Test its hardness with an ordinary steel-bladed jack-knife. Heat a small piece in the blow-pipe flame on charcoal. The yellow deposit is an indication of a lead ore. Powder the ore; mix with a little moist carbonate of soda, and heat in the blow-pipe flame. A metallic lead globule will be obtained very easily. Note the shape of the crystals of galena. This ore is a sulphide of lead, *i.e.*, lead and sulphur in combination.

Galena is of very common occurrence, and is usually associated with silver. Where is galena found?

QUARTZ

Quartz is so common, especially as the rock in which many minerals are found, that it must be thoroughly studied. It occurs in six-sided crystals and also in bed rock.

Secure the crystals, which are very common in houses as ornaments. Examine their form. Compare the shapes of different crystals.

Draw the sharp edge of the crystal over common window glass. Do the same with sharp-edged pieces of quartz rock. The different colors observed in quartz are due to foreign matter, manganese, chromium, etc.

Powder some of the quartz rock. Compare with white sand. Infer that clean, white sand is mostly quartz. Ordinary sand contains large quantities of other finely divided rock matter. What would be the effect of driving sand against glass? Devise some way of etching glass by driving sand against it.

Obtain ores of various kinds in quartz rock. Show pictures of quartz-veins in different kinds of rock.

Place small pieces of quartz in acids. Note result. Quartz in the form of pure, white sand is used in the manufacture of glass.

STONE

Secure samples of several kinds of stone—granite, limestone, sandstone, freestone, flint, quartz, etc. Let the pupils examine these in order to determine which is most suitable for building purposes. Why? The following points must be considered: ease of obtaining, quantity obtainable, ease in shaping, lasting qualities, appearance. If pupils live in a region where there is an outcrop of limestone or other rock, a visit should be made to a quarry. If no quarry is at hand, secure illustrations, photographs, etc., showing how the stone lies in strata. Sometimes the rock will be found with glacial striæ, or the surface will be found much weathered, and covered with a thin soil. These conditions will open up geographical questions of various kinds. What caused the striæ? What would the glacier do with any soil that had been formed on the rock? How do glaciers form lakes? Compare the upper layer of stone next the soil with the unexposed strata. What is rock gradually converted into? What agencies bring about this conversion?

LIMESTONE

After its adaptability for building purposes has been discussed, suggest the significance of the name.

Weigh a large piece, a pound or more, then place it in a hot coal fire or in a blue flame at an alcohol stove for some hours.

Compare appearance and other properties, before and after.

Weigh after heating. What is the result? Infer cause. Show illustrations of lime-kilns.

Place the resulting lime in water. Observe and describe all that happens. Collect some of the clear lime water and keep for future use.

Mix the slaked 'cream of lime' with sand, and let it dry. Let some of the lime dry without mixing with sand. Compare the two products.

In higher classes, it may be discovered that when limestone is heated, carbon dioxide is given off, and the pupils will be ready to infer that the hardening of the slaked lime is due to a re-absorption of carbon dioxide from the air. Test hardness of different mixtures of sand and lime, and thus discover the best proportion for building purposes.

Pupils have learned that carbon dioxide is given off from the lungs. Explain to them that lime-water is simply a solution of slaked lime in water. Blow air from the lungs through lime-water for a few minutes. Observe and note the results.

Test limestone with hydrochloric acid, and the gas that comes off for carbon dioxide, by passing it through lime-water, and by plunging a burning match into it.

The pupils should infer the likeness of limestone to the precipitate in lime-water when carbon dioxide is passed through it. Collect some of this precipitate and pour hydrochloric acid upon it. Compare results with action of acid on limestone. From these experiments the pupil may infer the mode of formation of our vast beds of limestone rock.

Observe the action of growing roots in contact with limestone. Infer connection with formation of soil.

Observe the action of the atmosphere on limestone rock. Compare with the "weathering" of granite and of sandstone.

Compare different forms of limestone — ordinary rock, marble, calcite. Test as above indicated.

LIGHT

In connection with the use of pictures and photographs in the study of various phases of the preceding work, the older pupils should be interested in making their own photographs by using a camera. Let them construct a simple pin-hole camera, *i.e.*, a dark box with a pin-hole in the middle of one

side, and a rack for a plate-holder opposite it. Secure photographs of simple objects with this.

To understand the working of this camera place a lighted candle in front of a large screen with a pin-hole in its centre, and hold a white sheet of paper behind the screen. Compare the image produced on the white paper with the candle. How can a small image be obtained? How can a large image be obtained? How can the image be made more distinct? Trace the course of each ray of light from each point of the candle through the pin-hole to the image.

Examine the structure of a simple camera. Discover the action of the simple lens in producing the picture. After the pupils have found that a simple lens is the only mechanism used in photographing, give them a simple lens to experiment with, using a lighted candle in a dark room.

Place the candle in different positions on one side of the lens, and cast the image upon white sheets of paper on the opposite side of the lens.

The problems to be solved are: Can a photograph of an object be secured at any distance from it? Is there any one position better than another? Can you get too close to the object? Can you get too far away? What determines the size of the picture?

Being interested in photographing, the pupils will discover, without much assistance, the laws of images formed by lenses.

In the same connection they can be introduced to the phenomena of reflection and refraction of light; the formation of the spectrum, and to the use of lenses in telescopes, microscopes, etc.

HINTS FOR CLASS WORK ON PLANTS

Children can be introduced to the study of plants as easily as to any other subject. Just as they learn to know their playmates, so they may learn to know their friends of the woods and fields. When they are interested in a plant because of any feature of it, and ask "What is this?" the teacher should hasten to give them a formal introduction—"Why, that is Wake-Robin, who lives in the woods over there," or "That is my Lady's Slipper, which was lost many years ago in the forest. Let us learn more about it."

A touch of reality is added by this personification, which is really more strictly in accord with the truth than to consider a plant as so much dead matter. Fancy introducing a child of fourteen years or less to a living incarnation of beauty, in the terms of a dead language, *Cypripedium pubescens!*

The flower should be first treated and studied as a living thing, and afterwards used as material for drawing lessons and for color study.

We may learn something from Nokomis in Longfellow's *Hiawatha*. She was grandmother and teacher to him.

"Many things Nokomis taught him
Of the stars that shine in heaven;
Showed him Ishkoodah, the comet,
Ishkoodah, with fiery tresses;
Showed the death dance of the spirits,
Warriors with their plumes and war-clubs,

Flaring far away to northward
In the frosty nights of winter;
Showed the broad white road in heaven,
Pathway of the ghosts, the shadows,
Running straight across the heavens,
Crowded with the ghosts, the shadows."

* * * * * * *

"Saw the rainbow in the heaven,
In the eastern sky the rainbow,
Whispered, 'What is that, Nokomis?'
And the good Nokomis answered:
''Tis the heaven of flowers you see there;
All the wild flowers of the forest,
All the lilies of the prairie,
When on earth they fade and perish,
Blossom in that heaven above us.'"

* * * * * * *

"Of all beasts he learned the language,
Learned their names and all their secrets;
How the beavers built their lodges,
Where the squirrels hid their acorns,
How the reindeer ran so swiftly,
Why the rabbit was so timid,
Talked with them whene'er he met them,
Called them Hiawatha's brothers."

Here was an ideal teacher of nature. There was no dissecting, but a living interest in what these things did.

By some such simple method, the child should, in the course of an ordinary school life, become acquainted with the names of all our common trees and plants. As soon as he is able, he should note likenesses and differences, beginning with the grosser and gradually extending to the finer details; but the teacher must keep within the limits of interest, direct the pupil's efforts, yet see that knowledge is acquired through his own self-activity. Classification into orders, genera, and species, should be left for more advanced school-work.

While becoming acquainted with the names of trees and plants, quite young pupils can begin systematic work, which requires only keen eyes and an interested mind to accomplish. They should note where the plants grow, the color of the flowers, kind of soil, etc., and prepare lists of plants according to habitat :—

Plants growing in water—Sagittaria, Eel-grass.
" " sandy soil—Clot-bur, Evening Primrose.
" " woods—Lily, Anemone.

If such work as this is begun in the second grade and continued throughout the school course, the child will have a store of information about plants which will be of the greatest value whatever his future may be.

Another line of work, similar to the above, is grouping plants according to time of flowering ; at first, by seasons, then by months, and later by definite limiting dates, showing earliest and latest appearance in bloom.

As a guide to teachers and as an indication of the work that might be done by the pupils in the course of seven or eight years, a list of common plants, grouped according to habitat and color of flowers, is given in the appendix.

In the past, the study of plants in our schools has been limited almost entirely to minute descriptions of individual plants, with a view to their exact classification. While this work is quite in place for the advanced student, it is quite unsuited to the younger classes. Furthermore, the basis of classification has been the flower to the exclusion of the leaf. As the latter is a much more permanent part of the plant than the flower, a classification based upon it has many advantages. In any case, children should be trained to recognize plants by their leaves and general appearance, so that they can gather and examine them at any time during the season.

After a class has once learned to know a plant, this should be collected at regular intervals, say every month, and its development and changes noted. The importance of such examination may be seen in the case of the Dandelion, which, immediately after it has bloomed, should be examined daily until the fruit is fully formed. Then the life story of it may be written just as we would write the life story of a frog or other animal.

This periodic examination will lead up to the study of the formation and development of fruit and the dispersal of seeds. The seeds should be preserved in labelled packages, planted in the following spring, and their germination and early growth noted. Thus the observation of the life cycle would be completed.

While doing such work as the above, the pupils will discover the distinction between annuals, biennials, and perennials. Usually this distinction is brought before the student after a few months of study, but evidently no one can appreciate the distinction until a type of each class has been studied for two or more years.

Thus the study of plants in the large will be followed by the study of their more particular structure, the buds, leaves, flowers, fruit, and seeds. Each of these may be taken in turn and studied minutely.

Bring into your school-room, in March, branches of different trees, *e.g.*, maple, apple, horsechestnut. Keep their cut ends immersed in water or in moist soil (cutting the ends occasionally), and observe the development of the bud. What becomes of the brown scales? How is the bud protected? Where are the buds situated? Which buds develop first? Are there any which will not develop in the room? Observe the development of buds on the tree later. What is a bud? How does it grow? Find the buds which

become flowers. Which appear first—the leaves or the flowers?

On the maple tree the flowers are noticeable first; on the apple tree, both develop together; while the horsechestnut tree is in full foliage before the flowers unfold. Try to discover other trees like each of these types, in respect to the appearance of the flowers and the leaves.

Following the plan suggested in a preceding paragraph, observe these trees at least once a month throughout the season. The development of the fruit should be followed closely, and a record of observations kept. Does each blossom produce a fruit? If not, about how many of the blossoms do produce fruit? Of fruits which set, how many mature? What causes some of the fruits not to develop? Open those fruits which fall early to discover the cause of their non-development.

Examine the structure of the fruits of the three trees mentioned. In the maple fruit, the peculiar wing and manner of falling are noticeable; in the horsechestnut, the bur or shell, and the richly-colored brown nuts; in the apple, the fleshy fruit and the seed-cavities. How many seed-cavities are there? How many seeds in each cavity? Look for other fruits like each of these types. The ash and the elm have winged fruits; the chestnut and beech-nut have burs; the pear and quince are fleshy. Why are fruits green while immature, and brown when ripe? Do these colors protect them in any way?

In higher classes the study of buds may be continued in order to find when, where, and how new buds are formed each year. Examine the branches closely each month. You will find that the buds are formed early in the season, before the leaves fall. Where are they formed? How and when are they coated with resin? What other protection have

they? Open one to see. Try to discover all that is contained in a bud. Examine the marks (scars) left by the leaf after it has fallen from the tree; also the ring-like marks of the scales of a bud. The distance between two successive ring-like marks represents a year's growth, hence the age of a shoot can be determined by observing these. Confirm your estimate of the age in this way by counting the rings of the wood in the shoot.

The terminal buds continue the growth of the stem next year. Some of the lateral buds never develop unless some accident happens to the terminal buds. Break off the terminal buds of healthy branches on a tree, and note the result.

A few years ago the larvæ of the Tussock Moth destroyed the entire foliage of shade trees in Toronto and elsewhere. Later in the season the trees not only were covered with new leaves but flowers as well. Sometimes, in the spring, trees leaf out early and have their foliage totally destroyed by late frosts, but the reserve buds are sufficient to renew the foliage, and prevent the death of the trees.

During the winter, trees and shrubs should be observed as to outline, habit of branching, nature of bark, etc. Leafless trees are especially valuable as objects of drawing-lessons, and birds' nests can then be observed, which escape detection during the summer.

The nature of the wood itself should be studied, so that unscrupulous dealers could not pass off black ash for oak, or stained pine for mahogany.

In the autumn observe the falling of the leaves. Some trees shed their leaves suddenly, *e.g.*, horsechestnut, walnut; some shed them gradually, *e.g.*, maple, poplar; some retain a few brown and withered leaves throughout the winter, *e.g.*, oak, beech. When do these latter leaves fall?

Why? Group the trees according to these different ways of shedding their leaves.

Study the evergreens. Do they shed their leaves? One is apt to answer "No," but is immediately reminded of the beds of pine needles which carpet the ground under old pines. Cut off a branch of a pine or a spruce which has a leafless portion. Observe the different years' growths. Examine the leaves on each year's growth. Which year's growth is entirely leafless? What portions have lost part of the leaves? What portions have lost no leaves? Compare different evergreens, as some shed their leaves in a different way from others. In what way are evergreens better adapted to withstand winter weather than maples? Which kind of tree will likely flourish better far to the north?

The cause of the falling of leaves is not, as is generally supposed, due to frost, though a frost may hurry the process. The leaves would die if there were no frost, as you may observe many do early in the season. A growth of special tissue occurs at the base of the stem and cuts off the food supply The leaf then dies.

ROOTS

There are many interesting facts about roots which may be made the subject of Nature Study. They must be distinguished from underground stems which bear buds. In origin they grow from the descending axis of the plant. Observe sprouting seeds and distinguish the ascending axis (stem) from the descending axis (root). Examine the small rootlets for the root-hairs which absorb water. Where are these root-hairs most numerous? Why are roots so irregular compared with stems? How would the soil affect the regularity of a root?

Each root has a root-cap at its tip, which is constantly

renewed as it is worn off by the soil, through which it forces its way. This root-cap is a very important part of the root.

Examine the roots of clover plants and other members of that family of plants (bean, pea, etc.), and you will find small enlargements called "nodules." These nodules play a very important part in the nourishment of these plants, as they are tenanted by minute forms of plant life (bacteria) which have the power of assimilating nitrogen directly from the air. The majority of plants and animals cannot do this. Thus the plants of this family are rich in nitrogen, and are valuable fertilizers of the soil, as farmers have long known. A crop of clover plowed under is the very best preparation for a crop of wheat. In Germany these bacteria have been cultivated and prepared for sale, just as phosphates are sold as fertilizers.

One of the best Nature Study exercises is to have each pupil plant a dozen or more seeds of various kinds, and report each week or oftener upon their growth. The teacher should keep a few seeds of the same kind growing for class demonstration, to correct errors and suggest new work.

TREES THAT SHED THEIR BARK

We are all familiar with the phenomenon of trees shedding their leaves. We know, too, that in spring they shed the scales which enclosed the buds all winter. Later they shed most of the parts of the flower—the calyx, the corolla, and the stamens. Then, at the close of the season, the fruit falls. There are exceptions to nearly all these statements, but, generally speaking, they are true.

Most of our trees shed their bark also. This is most evident in the sycamores and birches, but it is none the less true of other trees. In winter the branches of the sycamore glisten along the river valleys, and the lateness of the leaves

in spring marks these trees distinctly against the surrounding greenness. This process of shedding the bark is quite evident in the white pine, from which the bark scales in rather regular four-sided patches. The shag-bark hickory sheds its bark in strips. This peculiarity gives the name to the tree. The rough surfaces of the maple, oak, walnut, and other trees show that the same process is going on there, though less regularly. It is, in fact, a necessity of their mode of growth.

The growth of our common trees takes place in the area just under the bark, between the bark and the wood. This area is called the 'cambium,' and it grows both inwards and outwards, forming wood on the inside and bark on the outside. As the tree increases in circumference, the bark of previous years' growth is shoved outward, but being too small to cover the increased circumference, it splits more or less irregularly, and eventually scales off—very quickly and completely in the sycamore—more slowly in the maple and other trees.

Some trees, *e.g.* palm, and some plants, *e.g.*, corn, do not grow as above described, and on these there is no bark, although the outer layer of cells are somewhat different from the inner ones. These trees and plants have points of growth throughout the stem, and the wood is formed at these points in distinct bundles. These bundles can be seen if a corn stem is cut across.

The plants of the first class have net-veined leaves; the parts of the flowers are in fours or in fives, and when the seeds germinate they send up two small leaves (cotyledons). The plants of the second class have straight-veined or parallel-veined leaves; the parts of the flowers are in threes or in sixes; and when the seeds germinate, they send up but one leaf (cotyledon). The former are known as Dicotyledons or

Exogens; the latter as Monocotyledons or Endogens. In these two classes all plants which bear flowers can be placed.

In the more advanced classes, the pupils should observe the relation between plants and the soil. Some plants flourish best in sandy soil, and are apt to crowd other plants out which might be able to grow there, if not in competition with these natives, as they may be called. Other plants grow in water, and cannot possibly live on dry land. Others grow in swamps; others in shady woods; some in sunny places, and some prefer mineral soil. Thus evergreens prefer sandy or gravelly soil, while the hardwood trees—oak, maple, beech—need a heavier soil, clay loam. Willows and sycamores grow beside flowing streams, and tamarack in cold, wet soils. The study of these groups of trees may be carried on for several years.

Modern botany places great stress upon the adaptation of plants to environment. This phase of the subject is known as Ecology. Plants are found to grow in societies, according to the kind of soil, amount of moisture, and nature of the climate. Thus we have peat-bog societies, swamp societies, forest societies, desert societies, fence-corner-, and roadside societies.

Four great societies are now recognized :—

(1) Water plants, *i.e.*, those which grow where water is abundant (Hydrophytes).

(2) Drought plants, *i.e.*, those which grow in extremely dry soil, and in a dry atmosphere (Xerophytes).

(3) Plants which grow where there is a medium water supply (Mesophytes).

(4) Plants which grow in soil which contains a large amount of mineral matter (Halophytes).

At the same time we must bear in mind that the same

species of plant may flourish under quite different conditions, and these conditions affect the structure of the plant. In elementary work, plants should be grouped as indicated in the Appendix. The technical terms used above should be introduced in advanced classes only.

EXPERIMENTS WITH PLANTS

In the higher classes a great deal of experimental work in botany may be done. The experiments should, as far as possible, be suggested by the teacher or the pupils in order to solve some problem which has arisen in connection with the study of plants. If the pupils are caring for plants, some of which thrive, while others do not, encourage them to suggest possible causes of the difference, and then arrange experiments to test their theory. One may suggest that the soil is too wet. Experiment by placing two plants in similar conditions, and keeping one quite wet while the other is kept just moist. The experiments given here, in order, are not, therefore, intended to be taken up merely for the sake of experimenting, but for the purpose of solving some problem which has arisen in connection with the immediate experience of the class :—

1. Immerse a growing leaf in a glass of water and place in direct sunlight. Compare with results obtained in dim light.

2. Obtain some water-plants which grow immersed in water. Place a large funnel over them in the water. Invert a test tube, filled with water, over the stem of the funnel, and thus collect the gas which is given off. Thrust a glowing splinter into the gas. If the splinter bursts into a flame the gas is oxygen.

3. Place a growing plant under a glass jar, along with a dish filled with lime-water. Make the whole as nearly airtight as possible. Observe the effect on the lime-water after standing over night. Infer the cause.

4. Place a growing plant under a large, clean, dry bottle. What gathers on the bottle? Where does it come from? How does a plant prevent the escape of too much moisture?

5. Put some peas, which have germinated, in a closed bottle, and some in an open bottle. Which grow better? Why? Infer proper conditions of growth. How does too much water about the roots of a plant affect its growth? Why?

6. Show the pupils how acids attack limestone. Plant peas in a shallow layer of soil on a slab of limestone, and keep the stone in an inclined position until good roots are developed in contact with the limestone. Then remove the soil and examine the limestone. What caused the markings on the stone? What would be the result in time? Infer how growing plants aid in forming soil.

7. Place slips and cuttings in moist sand and some in moist loam. In which do they develop better? Why?

8. Show how grafts are set, and how strawberry plants spread by runners. What is the advantage of a graft over a slip or a cutting?

9. Place a plant in different positions with respect to light, and observe the change in the position of the leaves. Examine different plants to discover how the greatest extent of surface is exposed to light.

10. Make a thin solution of starch in water. Add a drop of iodine solution. Note the result. Heat gently, and then allow the solution to cool. This is a test for the presence of starch.

11. Test pieces of potato, wood, leaves, fruit, stems, etc., for starch by the iodine test.

12. Place green leaves in warm alcohol, or in chloral hydrate for a day. What is removed from the leaf? Test the bleached leaf for starch. Test variegated leaves of

foliage plants in this way to discover where starch is found.

13. Compare the greenness of plants grown in different light. Where is green coloring matter formed better, in sunlight or in shade? In which is most starch formed?

14. Test beans, peas, wheat, potatoes, etc., for starch. Test the sprouts of potatoes, which grow in the cellar, for the presence of starch.

15. After pea seedlings have reached a height of two or three inches, plant them with roots up, and observe results.

16. Devise experiments to discover whether roots grow towards or away from water or moist soil.

17. Plant different seeds and observe their mode of coming out of the ground. By planting in glass vessels, near the sides, the whole process of germination may be observed.

18. Mark parts of stem and root with indelible ink, and discover where the greatest growth in length takes place.

19. Plant seeds in two different pots. After they have come up, put a strong solution of ammonia on the soil of one, and a very weak solution on the other. Infer cause of difference in growth. Experiment with other solutions.

20. Place strips of dandelion stem in fresh water and then in salt water.

21. Roots absorb water. Leaves give off water. Are these quantities of water equal or not? Plant wheat in a pot. When it is growing well, place under a fruit jar in a warm place. Observe changes after a few hours. Why do plants wilt?

22. An interesting test of plants giving off water-vapor may be made as follows:—

Saturate clean white blotting paper with solution of cobalt chloride (red). Dry it thoroughly, noting its change of color. How could it be used to show the presence of moist-

ure? Hold it near the leaf of a growing plant. What does the change in color indicate?

23. Water growing seedlings with colored water. After a day or so examine the roots to discover at what point absorption takes place.

24. Water begonias with colored water. Trace its course through the plants.

25. With cobalt chloride paper, show that moisture is given off from the under side of a leaf more rapidly than from the upper side. Place a geranium leaf between two pieces of the paper, and then press the whole between two plates of dry glass.

ACCORDING TO SEASON

"Who covereth the heaven with clouds, who prepareth rain for the earth, who maketh grass to grow upon the mountains.

"He giveth to the beast his food, and to the young ravens which cry.

"He sendeth forth his commandment upon earth: his word runneth very swiftly.

"He giveth snow like wool: he scattereth the hoarfrost like ashes.

"He casteth forth his ice like morsels: who can stand before his cold?

"He sendeth out his word, and melteth them: he causeth his wind to blow, and the waters flow."—Psalm CXLVII.

JANUARY AND FEBRUARY

"Bite, frost, bite!
You roll up away from the light,
The blue wood-louse, and the plump dormouse
And the bees are stilled, and the flies are killed,
And you bite far into the heart of the house,
But not into mine." *Tennyson.*

MAMMALS.—Study the tracks in the snow to see what mammals are active in the winter. Distinguish between the tracks of the Wood Hare, Squirrel, and Field-mouse. Where do animals get their food in the winter? Do they ever dig beneath the snow for it? Do you ever find the tracks of the Fox, Raccoon, Skunk, Mink, Weasel, or Porcupine? How do the Raccoon, Skunk, Porcupine, Woodchuck, Flying-squirrel, Chipmunk, and Bat pass the winter? What animals change color when the snow comes? If possible, examine a Musk-rat stream or pond. How do the Muskrats pass the winter? In your walks through the woods look in the saplings and

wild-grape vines for the summer nests of the Red Squirrels and the Flying Squirrels.

For the purpose of study, Rabbits, Red Squirrels, and Chipmunks may be kept in captivity during the winter, but must be carefully attended to.

Birds.—Make a list of the birds that you observe. Distinguish between those that are winter visitors and those that are permanent residents. What birds do you find in the winter? (*a*) in the fields? (*b*) in the woods? (*c*) in the city? In the woods, make a special study of the Woodpeckers. In the city, look in the mountain-ash trees for the Cedar Waxwings. If the winter is severe and the snow is deep, keep a careful watch for the Pine Grosbeaks and the Bohemian Waxwings.

Notice the different kinds of birds that go in company. Upon what does each species live? Where do birds find shelter at night? What birds of prey are active in the winter? Upon what do they live?

Winter is the best season to study birds' nests. Pull the old nests to pieces and examine their materials and structure. Make a note of their location.

Plants.—Study buds and twigs. Draw forms of leafless trees. Compare modes of branching. Study the evergreens. How do they shed their leaves? Look for seeds blown over the snow. Dig under the snow for plants.

Insects.—Look for flies and mosquitoes in the house.

Spiders.—Look for spiders in the house, under boards, and out of doors.

Slugs.—Turn over logs and see what the slugs are doing all winter.

Wood-lice.—Along with slugs will be found wood-lice, which may also be studied.

CRAYFISH.—These may be kept all winter in stagnant water, and studied when convenient.

MARCH

"Go, Winter! Go thy ways! We want again
The twitter of the bluebird and the wren;
Leaves ever greener growing, and the shine
Of Summer's sun—not thine.—

"Go get thee from us! We are cold, God wot,
Even as *thou* art.—We remember not
How blithe we hailed thy coming. That was O
Too long—too long ago!

"Get from us utterly! Ho! Summer then
Shall spread her grasses where thy snows have been,
And thy last icy footprint melt and mold
In her first marigold."

J. Whitcomb Riley.

MAMMALS.—The mammals which have hibernated during the winter begin to wake up. Watch for the Woodchuck, and the Chipmunk, and note the dates when they first appear. When the snow melts off, walk across the fields and examine the runways of the Meadow-mice in the grass.

BIRDS.—The winter visitors begin to return north. Notice the flocks of Snowbirds and Horned Larks in the fields. Upon what do they feed? Examine the flocks carefully to see if there are any Longspurs or Redpolls among them. Between March 8th and 12th look for the first Robins, Bluebirds, and Song Sparrows. Note the dates of their return each year. Watch for the return of the Crow, Mourning Dove, Meadowlark, Redwinged Blackbird, and Flicker, and note the dates. About March 31st begin to look in the fields for the nest of the Horned Lark.

PLANTS.—Gather twigs of apple, maple, horsechestnut, pussy-willow, lilac trees, etc. Keep their cut ends in water in

the school-room, and observe the bursting of the buds. Note any buds which open out-doors. Look for Skunk-cabbage. If the weather is mild,you may find the Hepatica in flower before the end of the month. Observe Mosses and Lichens also.

Insects.—Watch for Mourning Cloak and Milbert's Tortoise Shell Butterflies in the woods. Look for ants, wasps, and bees. If the weather is warm, Water-striders and other aquatic insects will appear.

Spiders become more abundant.

Crayfish sometimes come out of their holes.

Frogs.—Note the date of the first singing of frogs. How many different sounds can you distinguish?

APRIL

"O hush, my heart and take thine ease,
For here is April weather;
The daffodils beneath the trees
Are all a-row together.

"The thrush is back with his old note;
The scarlet tulip blowing;
And white, ay white as my love's throat,
The dogwood boughs are growing.

"The lilac bush is sweet again;
Down every wind that passes
Fly flakes from hedgerow and from lane;
The bees are in the grasses.

"And grief goes out, and joy comes in,
And care is but a feather,
And every lad his love can win,
For here is April weather."

Lizette Woodworth Reese.

Read also Tennyson's *Early Spring*.

Mammals.—Examine the burrows of the Woodchuck, and

notice the fresh earth thrown up. Watch for Muskrats in the streams and ponds. Look for the ridges of earth thrown up by the Moles in the gardens and fields. The Black and the Red Squirrels are caring for their first brood of young. Most of the mammals get new coats for the summer.

Birds.—Observe the dates of the arrival of different birds from the south, and note the different flocks of migrants passing north. What birds begin nesting in April? Notice especially those that nest in holes in trees and stubs.

Plants.—Collect early flowering plants. Note the opening of the buds of trees, and the appearance of leaves and flowers. Note the evergreens also. Look for Partridge-berries in the woods. Observe the development of the Skunk Cabbage. Plant seeds and observe the process of germination.

Insects.—From cocoons kept in the school-room through the winter, moths begin to emerge. Observe the Cecropia, Polyphemus, Promethea. Make notes of the insects observed. Collect larvæ of the Isabella Moth, and feed them.

Frogs. Collect frogs' eggs and toads' eggs. Keep them in a shallow dish in the school-room, and observe their development.

Fish begin to ascend streams to spawn.

Clams may be found in the creeks.

Crayfish will have eggs attached to the abdomen. Keep these and observe development.

MAY

"I, country-born an' bred, know where to find
Some blooms thet make the season suit the mind,
An' seem to metch the doubtin' bluebird's notes,—
Half ven'trin' liverworts in furry coats,

Bloodroots, whose rolled-up leaves ef you oncurl,
Each on em's cradle to a baby pearl,—
But these are jes' Spring's pickets ; sure ez sin,
The rebble frosts 'll try to drive 'em in ;
For half our May's so awfully like Mayn't,
't would rile a Shaker or an evrige saint ;
Though I own up I like our back'ard Springs
Thet kind o' haggle with their greens an' things,
An' when you most give up, 'uthout more words."
Toss the fields full o' blossoms, leaves, an' birds."

Lowell.

MAMMALS.—Most of the mammals are occupied with the care of their young. Look for Flying Squirrels in old trees and stubs. If you see a hole, hammer on the trunk with a stout stick and watch the result. Note the date when you see the first Bat. Watch for Wood Hares in the underbrush.

BIRDS.—Notice the flocks of White-crowned and White-throated Sparrows returning to the north. Watch also for migrating Warblers. Observe the dates of the return of the rest of the birds. May is the month of song. Try to distinguish the different songs and calls. Make a close observation of the breeding habits of as many species as you can.

PLANTS.—Continue your collection, noting the places where the plants are found, and the dates. Observe the growth of seedlings—maples, etc. What trees burst into leaf and flower? (See Appendix for a list of flowers to look for.)

INSECTS.—Look for the emergence of moths. Watch lights at night for the appearance of moths. Note the relation between the development of certain plants and the emergence of moths. Collect eggs of the Apple-tree Tent Caterpillars and keep them in a breeding cage to observe the hatching, and, later on, the larvæ and chrysalis. In Sep-

tember the moths will emerge. Note whether May-flies appear in May or not.

SPIDERS' webs become quite common.

FROGS, ETC.—Continue the study of tadpoles in the class-room. Look for clams with thick, red gills. These contain eggs. Observe their development. Look for turtles in the streams. Continue the study of fish.

JUNE

"When June is here—what art have we to sing
The whiteness of the lilies midst the green
Of noon-tranced lawns? Or flash of roses seen
Like red birds' wings? Or earliest ripening
Prince-Harvest apples, where the cloyed bees cling
Round winey juices oozing down between
The peckings of the robin, while we lean
In under-grasses, lost in marveling.
Or the cool term of morning, and the stir
Of odorous breaths from wood and meadow walks;
The bobwhite's liquid yodel, and the whir
Of sudden flight; and where the milkmaid talks
Across the bars, on tilted barley-stalks
The dewdrops' glint in webs of gossamer."

J. Whitcomb Riley.

MAMMALS.—Squirrels of all kinds are plentiful. Observe their habits. Watch the Woodchucks at the mouth of their burrows. Examine the banks of the stream for the summer burrows of the Muskrats.

BIRDS.—Continue the study of the nesting habits of birds. Look for the nests of the Cuckoo, the Waxwing, the King-bird. What birds do you find nesting for the second time? Before the end of June some of the birds have stopped singing. Why? What bird-songs continue? Listen for the Robin-like song of the Red-eyed Vireo, "the preacher." Make a study of young birds.

PLANTS.—Continue the study of plants. Look for the rare Lady's Slipper, Pitcher Plant, Orange-red Lily. Study the leaves of trees. Observe the setting of fruits. Observe the heading of wheat, etc.

INSECTS.—Butterflies begin to appear in great numbers. Why? Look for eggs and larvæ of the Potato Beetle, the Cabbage Butterfly, the Eastern Swallow-tail. Collect insects around the electric lights. Look for grasshoppers. Note the development of wings. Begin to observe the songs of crickets, etc., at night. Look for the larvæ of the Dragon-flies.

TURTLES now lay eggs in sand-banks. Try to find some. If a nest can be found and removed in a box of sand to a convenient sunny place, the hatching may be observed in September.

JULY AND AUGUST

"Dead is the air and still! the leaves of the locust and walnut
Lazily hang from the boughs, inlaying their intricate outlines
Rather on space than the sky—on a tideless expansion of slumber.
Faintly, afar in the depths of the duskily withering grasses,
Katydids chirp, and I hear the monotonous rattle of crickets."

Bayard Taylor.

MAMMALS.—Continue the study of the smaller mammals. In harvest-time look for Wood Hares, and Field-mice in the harvest fields.

BIRDS.—Continue the study of young birds. Observe the nature of their food supplies. Look for the nests of Goldfinches in the smaller shade trees. Make a study of the birds along the river-bank—the Kingfishers, Swallows, Sandpipers, etc. What birds prepare to migrate during August?

PLANTS.—Flowers now become numerous in fields and by roadsides, but vanish from the woods. Observe the development of fruits, and the ripening of grains in order. What fruits ripen?

Insects.—These are gala days for butterflies of all sorts. Larvæ of some kind are found on nearly every plant. Those on cabbages, parsley, tomatoes, tobacco, apple trees, and other fruit trees, should be studied particularly. Dragonflies emerge from pupæ. Note the buzzing of the Cicada in hot days. The singing of insects at night is very marked. Study fire-flies. Under what conditions is the 'fire' produced? Make a careful study of different kinds of wasps, bees, and ants.

Spiders' webs become very common. Observe them and make drawings of different kinds.

SEPTEMBER

"Who hath not seen thee oft amid thy store?
Sometimes whoever seeks abroad may find
Thee sitting careless on a granary floor,
Thy hair soft-lifted by the winnowing wind;
Or on a half-reaped furrow sound asleep,
Drowsed with the fume of poppies, while thy hook
Spares the next swath with all its twined flowers;
And sometimes like a gleaner thou dost keep
Steady thy laden head across a brook;
Or by a cider press, with patient look
Thou watchest the last oozings, hours by hours."

Keats.

Mammals.—Make a study of the larger mammals where possible. Raccoons, Skunks, etc., are more numerous in the woods. When does the Woodchuck go into hibernation?

Birds.—The autumn migrations commence in September. Make note of the dates.

Plants and Trees.—Look for buds on the trees before the leaves fall. Note the change in color, and the falling of the leaves. Examine the fruits of plants studied earlier in the season. Study the distribution of seeds of the thistle, etc. Collect dry fruits for winter study. Flowering plants

are fewer. Those in flower are mostly composites—as Asters, Golden-rod, Yarrow; but Yellow Evening Primroses, Gentians, Butter-and-Eggs, still bloom. Begin the study of Mushrooms.

Insects.—What butterflies and moths are still found? What butterflies appear for the first time? Collect larvæ and cocoons to keep over winter. Observe the spinning of cocoons. How do insects' songs at night vary? What insects disappear? Observe the larvæ of the Potato Bug and the Tomato Worm go into the ground. Collect the galls on the Golden-rod and keep them through the winter.

Spiders.—This is a good month to study spiders and their webs. Look for spiders' nests. Keep some through the winter. Note the effect of cold, frosty nights on different animals.

Fish.—What fish are on the market?

Oysters.—This is the first month for oysters. Why? Examine one and compare it with a clam.

Note the opening and closing of the seasons for game, as stated in the game laws.

OCTOBER

"Ere in the northern gale
The summer tresses of the trees are gone,
The woods of Autumn all around our vale
Have put their glory on.

"The mountains that infold
In their wide sweep the colored landscape round
Seem groups of giant kings in purple and gold,
That guard the enchanted ground.

"I roam the woods that crown
The upland where the mingled splendors glow,
Where the gay company of trees look down
On the green fields below.

"My steps are not alone
In these bright walks; the sweet south-west at play
Flies, rustling, where the painted leaves are strown,
Along the winding way.

"And far in heaven the while,
The sun that sends the gale to wander here
Pours out on the fair earth his quiet smile,
The sweetest of the year."

Bryant.

MAMMALS.—This is the best month for the study of mammals. The smaller mammals are laying in their supplies for the winter. The Raccoon and the Skunk are feasting in preparation for winter. The Muskrat begins to build his mound in the stream or pond.

BIRDS.—Continue the study of migrations. What birds arrive from the north for the winter? What birds remain with us until the end of October? What food do the remaining birds live on?

PLANTS AND TREES.—Study the late flowering plants—the Gentians. Study the falling of the leaves, and the distribution of fruits, seeds, nuts, etc.

INSECTS.—What butterflies and moths are still seen? What insects have disappeared? What effect has the change of season on wasps, bees, and ants?

SPIDERS.—Continue observations. The webs disappear. Why?

CRAYFISH and aquatic animals disappear; where do they go?

FROGS AND TOADS disappear. Observe a toad bury itself in the terrarium. How do frogs and mud-turtles bury themselves?

FISH.—What fish are on the market?

NOVEMBER

"Bright yellow, red, and orange,
  The leaves come down in hosts;
The trees are Indian Princes,
  But soon they'll turn to ghosts;
The scanty pears and apples
  Hang russet on the bough;
It's Autumn, Autumn, Autumn late,
  T'will soon be winter now!"

Allingham.

Mammals.—What animals go into hibernation in November? When does the Chipmunk finally go into winter quarters? Watch the progress of the Muskrat's winter dwelling. When the first snow comes, look for rabbit tracks. You will not find any the first day. Why? What game do you find on the market?

Birds.—The migrations will be completed early in the month. Begin to study the winter birds. Note the open and close seasons for hunting Ducks, Partridge, etc.

Plants and Trees.—Study the Witch Hazel, which flowers after the leaves have fallen. Have any trees leaves on? Observe the condition of fall wheat and grass. Examine the coverings of buds. When are they formed? Notice the effect of frost on the vegetation.

Insects.—A few will yet be seen—as for example, the moth of the Tent Caterpillar. Examine the structure of empty wasp's nests.

Snails.—Observe how the land snails close up the mouths of their shells.

Fish.—What fish are on the market? What fish are in close season?

DECEMBER

"In a drear-nighted December,
Too happy, happy tree,
Thy branches ne'er remember
Their green felicity;
The north cannot undo them,
With a sleety whistle through them;
Nor frozen thawings glue them
From budding at the prime.

"In a drear-nighted December,
Too happy, happy brook,
Thy bubblings ne'er remember
Apollo's summer look;
But with a sweet forgetting,
They stay their crystal fretting,
Never, never petting
About the frozen time."

Keats.

Mammals.—What animals go into hibernation in December? Begin to study the tracks in the snow.

Birds.—Continue the study of the winter birds. Observe their food and shelter. Make lists of the different kinds found in company. Examine the structure of nests.

Trees.—Study the winter appearance of trees; the bark and the character of the wood. What is the benefit of the trees being leafless? Examine fruits and seeds collected in the fall. Examine the potato, the onion, and other vegetable forms. Does Witch Hazel develop fruit in the winter?

Insects.—Where are they? Find flies, mosquitoes, spiders, wasps, etc.

Spiders.—Observe development in the nest.

Pond Snails.—These may be kept in water. What do they do when it is cold?

Fish.—What fish are on the market?

COURSE IN NATURE STUDY

FIRST CLASS—Parts I. and II.

Sun, moon, and stars, their position and appearance. Color of sky at different times.

WINTER:

Ice and snow, Jack Frost, winter birds, trees in winter. Compare evergreens and deciduous trees.

SPRING AND SUMMER:—

Melting of snow, water. Coming of birds, names of common birds, what they eat and do. A bird calendar should be begun, recording the first appearance of each bird, and the name of the observer.

Names and color, place of growth, time of flowering of common flowers as Trillium, Spring Beauty, etc. Plant seeds and observe their growth.

Study squirrels, rabbits, etc., if living specimens can be secured and kept in cages for a few days. Stuffed specimens are poor material at best, but better than nothing.

FALL:—

A few common plants, seeds and fruits. Dissemination of such seeds as burs.

SECOND CLASS

More details about sun, moon, and stars. If an eclipse occurs, make use of it for a lesson, showing position of earth, moon, and sun.

Need of sunlight in rooms for ourselves and for plants. Effect of light on plants: movements of plants.

WINTER :—

Observe the forms of snowflakes.

Different forms of water — ice, water, steam. The change from one to the other. Observe how ice floats in water—how much immersed? Compare large and small pieces in this respect to discover how the same *proportion* is always immersed if ice is clean.

Buds of trees.—Study twigs of apple, maple, horse-chestnut, spruce. Does the spruce tree shed its leaves? How? Impress the fact that trees are alive all winter, but sleeping. What do all the birds do in winter? Where are the bears, coons, squirrels, frogs, butterflies, toads? (Fall work must precede.)

SPRING AND SUMMER :—

As before, but more in detail and more extensively. Whenever class is interested in a natural phenomenon, teach it. Bird and plant calendars.

Keep tadpoles in glass jars for six weeks. Observe changes to adult frog. Write life-history.

Study fish—how they swim and breathe. External features—scales, fins, eyes, mouth, gills.

Young mud-turtles are interesting water animals. If kept till the autumn they may be seen to bury themselves.

Observe burying of toads and frogs.

Collect larvæ from different plants, etc. Observe change to chrysalids.

FALL :—

Observe emergence of butterflies from chrysalids. Later, observe the cocoons and the chrysalids which live through the winter.

Collect cocoons, etc. Keep in cool place through the winter.

Observe departure of birds. Why do they leave? Use of birds. Kindness to them and to all dumb animals. Order of departure. Some stay all winter.

Look for buds on the trees before the leaves fall.

Observe the falling of the leaves, color, mode of falling. What becomes of fallen leaves?

Common fall plants—Yellow Evening Primrose, Butter-and-Eggs, Asters, Golden-rods, Gentians. Study the head of the wild or of the cultivated Sunflower to learn the nature of a Composite.

Fruits and seeds—dissemination of seeds as before; also by wind and water; by birds, by railway and other agencies.

The fruits of the apple, horsechestnut and maple, etc., should be examined throughout the year, growth noted, etc. Plants of economic importance, *e.g.*, wheat, flax.

Forms in which plants store up food and propagate themselves next season, *e.g.*, bulbs, root-stocks, tubers, corms.

THIRD CLASS

Motions of sun, moon, and earth; planets as they appear. Eclipses more fully. Study features of the heavens, noting common constellations. Position of sun at different seasons. Effect.

WINTER:—

As before, passing to consideration of glaciers, icebergs, avalanches, Arctic regions. Expansion of water when freezing—effects on soil, rock, etc.

Study structure of buds, twigs, shapes of trees, nests in them. Winter condition of former animals, also of flies, mosquitoes, crayfish, snails, clams, spiders. Cocoons and chrysalids kept through the winter.

Study of seeds and fruits. Write life-histories of apple, etc.

SPRING AND SUMMER :—

Collect plants, name them, preserve half-a-dozen at least. Group them through the year, according to place of growth —in water, swamps, moist soil, dry soil, sand. Begin to note classes.

Study leaves, particularly of trees, so as to recognize them.

Study bark, wood, and general appearance of common forest trees. Use and relation to soil.

Extent of forests in Canada. Pulp wood. Preservation of trees.

Birds and animals continued more in detail, taking first those which can be observed, but comparing with foreign species later.

Different kinds of fish—Whitefish, Herring, Perch.

Butterflies and moths. Collect larvæ and note transformation. Injurious species. How to detroy them. Spraying.

Life-histories of several common insects.

FALL :—

Cones of evergreens: keep in the house till seeds are discharged.

Plants, especially Composites. Detailed study of two or three as outlined for Butter-and-Eggs. Compare stems and roots.

Crayfish, spiders, ants, bees, wasps, snails, slugs, clams. Webs of spiders require considerable study. Special adaptation of these animals to mode of life. Instinct, instances of.

Comparison of features of two types of plants. Bean type and wheat type. Plant seeds of each. Note their structure and growth. Compare stems, leaves, and flowers. Place each plant studied in its proper class.

Improvement of species by grafting, by cultivation, by selecting choice seeds.

FOURTH CLASS

WINTER :—

Sun, moon, and stars still further studied.

Inquire into causes, *e.g.*, of cold weather.

Summarize knowledge learned, and arrange it in compositions :—

"Our Winter Birds."
"The Sleep of Plants."
"Hibernation of Animals."
"How Plants shed their Leaves," etc.

Simple experiments—physical and chemical.

SPRING AND SUMMER :—

Collection and classification of plants—at first into class and division, later into orders, genera, and species. The knowledge gained hitherto will make the use of a "key" easy.

Special study of injurious plants throughout the year. How to destroy them. Diseases of plants. Remedies.

Study of Fungi, Mosses, Lichens, Ferns in the large. Poisonous plants and parasites.

Summarize knowledge under heads :—

"How Insects benefit Plants."
"Cross Fertilization."
"Movements of Plants."
"Plant Enemies."

ANIMALS :—

Classify the animals into branches :—

Back-boned animals—*Vertebrates.*
Soft, boneless animals—*Molluscs.*
Jointed-legged animals—*Arthropods.*

Then Vertebrates into classes :—

Cat type—*Mammalia.* (Name as many as possible.)
Bird type—*Aves.* " " "

Lizard type—*Reptilia.* (Name as many as possible.)
Frog type—*Amphibia.* " " "
Fish type—*Pisces.* " " "

Study smaller forms of animal life, *e.g.*, Plant-lice and related pests, Buffalo Carpet Beetle, Caddis-flies, Clothes Moth.

Make an extended study of one class of animals, birds, fish, butterflies, moths, or spiders. Let pupils develop individuality.

Summarize as under—Plants. Relation to man. History of certain forms—when introduced; how they spread; loss to country, directly and indirectly; our duty towards animals.

APPENDIX

The numbers refer to the months. s=Summer; a s=All summer; l s =Late summer.

PLANTS OF ROADSIDES

Flowers, White

Shepherd's Purse (4-11)
Virginia Creeper (7)
Hedge Bindweed (a s)
Bouncing Bet (s)
Musk Mallow (6-9)
White Sweet Clover (7-9)
Wild Carrot (6-9)
Mayweed [yellow disk] (7-9)
Boneset (8-9)
Yarrow (7-9)
Asters (6-9)
Rib Grass [Black Plantain] (s)
Round-leaved Mallow (6-10)

Flowers, Yellow

Charlock (6-8)
Mustard (6-9)
Wood Sorrel (a s)
Butter-and-Eggs (6-10)
Yellow Sweet Clover (7-9)
Tansy (6-10)
Elecampane (s)
May Weed [white rays] (7-9)
Mullein (7-9)
Wild Sunflower (l s)

Flowers, Pink, Red, etc.

Sweet Brier (6-7)
Apocynum (6-7)
Bouncing Bet (s)
Catnip (7-9)
Musk Mallow (6-9)
Yarrow (7-9)
Teazel (6-8)

Flowers, Blue or Purple

Common Speedwell (6-8)
Wild Toad Flax (7-9)
Blue Vetch (6-8)
Chicory [also white or pink] (7-9)
Viper's Bugloss (6-8)
Asters (s)
Beggar's Lice (6-9)
Blue Vervain (5-8)
Self Heal (6-9)

PLANTS OF WOODS

Flowers, White

Hepatica (4)
Wood Anemone (4-5)
Rue Anemone (4-5)
Thimble Weed (a s)
Twin Leaf (4-5)
May Apple (5)
Star Flower (5)
White Avens (5-8)
Five-leaved Ginseng (6-8)
Wild Sarsaparilla (6)
Bunchberry (6)
Indian Pipe (6-7)
Squirrel Corn (4-5)
Leek (6)
Solomon's Seal (5-6)
False Solomon's Seal (s)
Wild Lily-of-the-Valley (5-6)
Wake Robin (4-5)
Painted Trillium (4-5)
Canada Violet (s)
Bloodroot (4-5)
Toothwort (4-5)
Mitrewort (5)
False Mitrewort (5)
Shin-leaf (6-7)
Dutchman's Breeches (4-5)
Wood Sorrel (6-7)

Flowers, Yellow

Yellow Violet (5)
Bellwort (5)
Yellow Lady's Slipper (6)
Blue Cohosh (4-5)
Wild Ginger (4-5)
Yellow Wood Sorrel (5-9)

Flowers, Pink, Red, etc.

Spring Beauty (4-5)
Wild Geranium (5-7)
Lousewort (5-7)
Purple Flowering Raspberry (6-8)
Wild Orange-red Lily (6-8)
Pink Lady's Slipper (6)
Twin Flower (6)
Herb Robert (6-8)

Flowers, Blue or Purple

Blue Violet (4-5)
Twisted Stalk (5-6)
Ill-scented Wake Robin (4-5)
Phlox (5-6)

Plant, Green

Jack-in-the-Pulpit

PLANTS OF SANDY SOIL

Flowers, White

Asters (s)

Flowers, Yellow

Rock Rose (7-8)
Hairy Puccoon (6-7)
Sweet Golden-rod (8)
Stone Crop (6-8)
Yellow Evening Primrose (6-9)
Columbine (6-7)
St. John's Wort (6-9)

Flowers, Pink, Red

American Sea Rocket (7-8)
Bush Clover (l s)
Clotbur (l s)
Bird's-eye Primrose (5-6)

Flowers, Blue or Purple

Wild Lupine (6-7)
Purple Gerardia (7)
Asters (s)

PLANTS OF DRY SOIL

Flowers, White

Thorn Apple (6-9)
Dodder [parasitic] (l s)
Wild Carrot (8-9)
Everlasting (4-5)
Fleabane [yellow disk] (6-7)
Ox-eye Daisy [yellow disk] (6-7)

Flowers, Yellow

Buttercup (6-9)
Five-finger (5-8)
Shrubby Cinquefoil (a s)
Silvery Cinquefoil (a s)
Evening Primrose (6-9)
Barberry (5-6)
Canada Cinquefoil (5-8)
St. John's Wort (s)
Mullein (7-9)
Black-eyed Susan (s)
Dandelion (a s)
Golden-rod (8-9)
Prickly Lettuce (6-9)

Flowers, Pink, Red, etc.

Great Willow Herb (7-9)
Milkweed (6-8)
Canada Thistle (s)
Wild Bergamot (7-8)

[illegible]

Flowers, Blue or Purple

[illegible] Violet [illegible]
Viper's Bugloss [illegible]
Ground Ivy (4-5)
Indian Tobacco (6-8)
Self Heal (6-9)
[illegible]gue (5-7)
[illegible]ckle (7-9)
[illegible]histle (7-10)
[illegible]ld Bergamot (7-8)

Flowers, Greenish-white

Poison Ivy (6-7)

PLANTS OF MOIST SOIL

Flowers, White

Choke Cherry (4-5)
Dogwood (6-7)
Cut-leaved Toothwort (4-6)
Plantain (s)
Poison Hemlock (6-8)
White Violet (5)
Elderberry (6-7)
Chickweed (a s)
Virgin's Bower (7-8)

Flowers, Yellow

Dog's-tooth Violet (4-5)
Meadow Parsnip (5-6)
Loosestrife (6-7)
Jewel-weed (s)
Moneywort (s)

Flowers, Pink or Red

Small Willow Herb (s)
Turtle Head (l s)
Cardinal Flower (8)
Mint (8-9)
Oswego Tea (s)

Flowers, Blue or Purple

Blue Flag (5-6)
Blue-eyed Grass (6-8)
Common Harebell (6-9)
Forget-me-Not (6-8)
Ground Ivy (5-6)
Nightshade (7-9)
Blue Vervain (6-8)
Fringed Gentian (8-9)
Closed Gentian (9-10)

SWAMP PLANTS

Flowers, White

Gold Thread (5-6)
Round-leaved Sundew (6-7)
White Swamp Honeysuckle (6-7)
Creeping Snowberry (5)

Poison Su[illegible] (6)
Water Hemlock [illegible]
Grass of Parna[illegible] [illegible]ay, both [illegible]

F[illegible]

Marsh Marigold (4-5)
[illegible] Marigold (s)

Flowers [illegible], Red, etc.

American Cranberry (6)
Showy Lady's Slipper (5)
Swamp Milkweed (s)

Flowers, Blue or Purple

Pitcher Plant [varies] (6)
Purple Avens (5-7)
Marsh Five-finger (s)
Skunk Cabbag[illegible] [illegible]d] (4)
Asters (7-9)

WATER PLANTS

Flowers, White

Wild Calla (6)
White Water Lily (a s)
White Water Crowfoot (a s)
Water Hemlock (a s)
Water Parsnip (a s)
Arrow Head (a s)
Water Plantain (l s)
Eel-grass (8)
Water Cress (5-6)

Flowers, Yellow

Yellow Pond Lily (5-8)
Yellow Nelumbo (7-8)
Potamogeton (7-8)
Yellow Water Crowfoot (a s)

Flowers, Blue

American Brooklime (5-9)

PRESERVING SPECIMENS

INSECTS

Collecting Boxes.—Tack a thin sheet of cork in the bottom of a cigar-box. Attach a strap or cord to the box so that it may be carried easily. After the insects have been in the poison bottle for half an hour, they may be removed and pinned in the cigar-box until you reach home.

PINS.—Special German pins for pinning insects should be obtained. Ask for Kläger or Schlüter pins, Nos. 3 or 5. All sizes are made from No. 0 to 9 or 10. The length of all is the same.

Vials and pill-boxes should be carried on insect hunting excursions for the purpose of holding small specimens.

PINNING SPECIMENS. Most specimens should be pinned through the thorax, but beetles should be pinned through the right wing-cover. Very small insects should be pasted on small pieces of cardboard and the pin passed through the cardboard.

SPREADING SPECIMENS.—A spreading block must be made, with a groove in the centre to receive the body. The width of the whole block should be four or five inches. A strip of cork should be laid along the groove into which the pins should be thrust.

The forewings of butterflies and moths should be placed in such a position that the hind margin of the fore-wing is at right angles to the body. This will bring the hind-wings into proper place. The insects should be left on the spreading board for two or three days, after which they may be pinned in shallow boxes and properly labelled. In addition to the name, record the date of capture and the locality.

Soft-bodied specimens, *e.g.*, larvæ, will have to be preserved in 75 per cent. alcohol, or in some other preservative fluid.

For permanent school use, it is better to mount specimens in small boxes, just large enough and thick enough to receive them. Glue the specimens to a rectangular piece of glass which will form the bottom of the box. The top of the box can be formed of a piece of glass of the same size as the bottom. Glue the glass to the sides of the box, and bind

he edges with passe-partout. Mounted in this way, both sides of the insect can be examined.

PLANTS

Plants are preserved by drying them under pressure. The collection, when properly arranged and labelled, is a herbarium. Each species should be represented by sufficient specimens to display the stems, foliage, flowers, and fruits. If the plant is an herb, its root should be shown. Aim to have a herbarium which will show the life-histories of a few typical species.

Dry the plants between blotters which are twelve inches wide and eighteen inches long. Felt carpet paper makes very good drying paper, and is much cheaper than blotting-paper. Place each plant in a folded sheet of a newspaper, and then lay the newspaper between the felt papers. The sheets may be piled one above another. On top place a board twelve by eighteen inches, and apply a weight of twenty or thirty pounds. The felt paper should be changed every day or so, until the plants are well dried. A week or ten days will dry most plants.

After the plants have been thoroughly dried, they should be mounted on strong white paper, eleven and a half by sixteen and a quarter inches. Small plants may be glued fast to the mounting paper, but large stems must be held in place by strips of gummed paper. Only one species should be mounted on a sheet, and in the lower right-hand corner the label should be glued. This label should give the place and date of collecting, name of collector, height of plant, color, nature of soil, etc., and the name of the plant. Both the common name and the scientific name should be given.

BOOKS FOR REFERENCE

For Sale by George N. Morang & Company, Limited
90 Wellington Street West, Toronto.

NATURE STUDY

Nature Study and the Child. C. B. Scott. D. C. Heath & Co., Boston. $1.50

Nature Study for Common Schools. W. S. Jackman. Henry Holt & Co., New York. $1.20.

Nature Study and Life. Hodge. Ginn & Co., Boston and New York. $1.50.

This is an admirable treatment of Nature Study from an economic standpoint.

Handbook of Nature Study. Lange. G. N. Morang & Co., Toronto. $1.00.

Nature Study in Elementary Schools. Wilson. G. N. Morang & Co., Toronto. 35 cents.

Animal Life. Jordan and Kellogg. G. N. Morang & Co., Toronto. $1.20

Animal Life, The Study of. T. A. Thompson. Charles Scribner's Sons, New York. $1.50.

Animal Forms. A text-book of Zoology. By D. S. Jordan and Harold Heath. G. N. Morang & Co., Toronto. $1.10.

Nature Study for Grammar Grades. By W. S. Jackman. G. N. Morang & Co., Toronto. $1.00

MAMMALS

Four-footed Americans. Mabel Osgoode Wright. G. N. Morang & Co., Toronto. $1.50.

Although the materials of this book are presented in story form, it will nevertheless be found to be the best reference book on the subject of mammals.

Wild Neighbors. Ernest Ingersoll. G. N. Morang & Co., Toronto. $1.50.

This book contains special studies of the Gray Squirrel, the Skunk, and other animals.

Squirrels and Other Fur-bearers. John Burroughs. Houghton, Mifflin & Co., Boston. 60 cents.

BIRDS

Our Native Birds. D. Lange. G. N. Morang & Co., Toronto. $1.00.

Citizen Bird. Mabel Osgoode Wright. G. N. Morang & Co., Toronto. $1.50.

Game Birds and Birds of Prey. Neltje Blanchan. Introduction by "Coquina" (G. O. Shields). Forty-eight colored illustrations. G. N. Morang & Co., Toronto. $2.25.

This valuable work is divided into four parts: Water Birds, Wading Birds, Gallinaceous Game Birds, and Birds of Prey. The book has a complete index.

Handbook of the Birds of Eastern North America. F. M. Chapman. Appleton & Co., New York. $3.00.

This is the best standard reference book for teachers' use.

Bird Life. F. M. Chapman. Appleton & Co., New York. $2.00.

Birdcraft. Mabel Osgoode Wright. G. N. Morang & Co., Toronto. $2.50.

Bird Neighbors. Neltje Blanchan. G. N. Morang & Co., Toronto. $2.25.

Bird Homes. R. A. Dugmore. G. N. Morang & Co., Toronto. $2.00.

Bird Portraits. Ernest Thompson-Seton. G. N. Morang & Co., Toronto. $1.50.

Birds of Ontario. Thomas McIlwraith. Wm. Briggs, Toronto. $2.00

Birds of Village and Field. Florence A. Merriam. A Bird Book for Beginners. Houghton, Mifflin & Co., Boston. $2.00.

First Book of Birds. Olive Thorne Miller. Houghton, Mifflin & Co., Boston. $1.00.

Second Book of Birds. Olive Thorne Miller. Houghton, Mifflin & Co., Boston. $1.00.

These books wi l be found helpful to beginners and to teachers of primary classes.

INSECTS

Life Histories of American Insects. C. M. Weed. G. N. Morang & Co., Toronto. $1.50.

Romance of the Insect World. L. N. Badenoch. G. N. Morang & Co., Toronto. $1.25.

A Manual for the Study of Insects. By J. H. Comstock, and Anna B. Comstock. Illustrated by 797 figures, and 6 full-page plates. Comstock Publishing Co., Ithaca. $3.75.

Insect Life. J. H. Comstock. G. N. Morang & Co., Toronto. $1.75.

The Insect Book. L. O. Howard. Wm. Briggs, Toronto. $3.00.

The Butterfly Book. W. J. Holland. Doubleday, Page & Co., New York. $3.00

Wasps and their Ways, and **The Honeymakers.** Margaret Morley. Dodd, Mead & Co., Boston and New York. Each, $1.50.

PLANTS

The Nature and Work of Plants. By D. T. Macdougal. G. N. Morang & Co., Toronto. 80 cents.

Study of the Biology of Ferns. By G. F. Atkinson. G. N. Morang & Co., Toronto. $2.00.

The Teaching Botanist. By W. F. Ganong. G. N. Morang & Co., Toronto. $1.10.

Botany. L. H. Bailey. G. N. Morang & Co., Toronto. $1.10.

For a complete list of Prof. Bailey's Works on Botany and Agriculture, see catalogue of G. N. Morang & Co.

Plants. J. M. COULTER. G. N. Morang & Co., Toronto. $1.80

Plant Relations. J. M. COULTER. G. N. Morang & Co., Toronto. $1.10.

Plant Structures. J. M. COULTER. G. N. Morang & Co., Toronto. $1.25.

How to Know the Wild Flowers. MRS. W. S. DANA. Charles Scribner's Sons, New York. $2.00.

A Guide to the Wild Flowers. ALICE LOUNSBERRY. William Briggs, Toronto. $2.50.

Nature's Garden. NELTJE BLANCHAN. Wm. Briggs, Toronto. $3.00.

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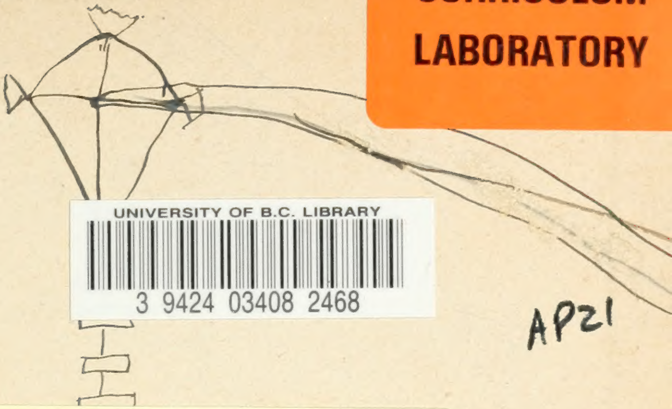

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